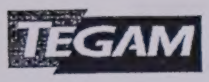

SG 5050
Rev. D

Instruction Manual
PN # 70505000

Programmable Leveled
Sine Wave Generator

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Geneva, Ohio, U.S.A.

Safety Precautions

This product is for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Exercise extreme caution when a shock hazard is present. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30 V RMS, 42.4V peak, or 60VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Users of this product must be protected from electric shock, and prevented access or insulated from every connection point. In some cases, connections must be exposed. Users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, no conductive part of the circuit may be exposed.

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to power mains.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. Always remove power from the entire test system and discharge any capacitors before connecting or disconnecting cables or jumpers, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument.

Replace fuses with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, not as safety earth ground connections. If a ground screw is present, connect it to safety earth ground.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

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Section 1
Specifications

Introduction

This section of the manual contains a general description of the TEGAM SG 5050 Programmable Leveled Sine Wave Generator and its electrical, environmental, and physical specifications.

Instrument Description

The SG 5050 Programmable Leveled Sine Wave Generator is a GPIB programmable TM 5000 Series plug-in instrument designed to provide a low-distortion sinusoidal waveform with leveled output amplitude. Frequency, amplitude, and the front panel store/recall parameters are fully programmable. Eight 7-segment LEDs display parameter values in the display window. The SG 5050 output is programmable in amplitude from 4.5 mV to 5.5 V peak-to-peak into 50Ω, and in frequency from 10 kHz to 2.5 GHz.

At power-up, the instrument performs a self-test and assumes the settings in use when previously powered down, with the exception that the output is in the "OFF" condition. Up to 20 user-definable instrument configurations can be stored in memory.

Rear interface connections provide access to versions of all front panel signals except the main output.

Output Leveling Head

Each SG 5050 is supplied with a matching Output Leveling Head. This leveling head must be installed on the SG 5050 at all times for proper operation.

A label attached to the leveling head identifies the serial number of the SG 5050 to which the leveling head is calibrated. If it is necessary to change leveling heads, the complete Adjustment Procedure must be performed to match the new leveling head to the SG 5050. After adjustment, it is recommended a new identification label be attached to the leveling head.

IEEE-488 (GPIB) Functions

The SG 5050 can be remotely programmed via the digital interface specified in IEEE Standard 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation. In this manual, the digital interface is called the General Purpose Interface Bus (GPIB). The IEEE-488 factory address is set to 10.

The IEEE standard identifies the interface function repertoire of an instrument on the GPIB in terms of interface function subsets. The subsets that apply to the SG 5050 are listed in Table 1-1.

NOTE

Refer to IEEE Standard 488.1-1987 for more detailed information. The standard is published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, New York 10017.

Table 1-1: Interface Function Subsets

Function	Subset	Capability
Source Handshake	SH1	Complete Capability
Acceptor Handshake	AH1	Complete Capability
Basic Talker	T6	Responds to serial poll. Untalks if My Listen Address (MLA) is received.
Basic Listener	L4	Unlistens if My Talk Address (MTA) is received.
Service Request	SR1	Complete Capability
Remote-Local	RL1	Complete Capability
Parallel Poll	PP0	Does not respond to Parallel Poll
Device Clear	DC1	Complete Capability
Device Trigger	DT0	Does not respond to GET
Controller Function	C0	No controller function
Electrical Interface	E2	Tri-state drivers

Electrical Characteristics

Performance Conditions

The limits stated in the Performance Requirements column of the following tables are valid with the following conditions:

- All measurements are made at the output connector of the Output Leveling Head. The SG 5050 must have been adjusted with the same leveling head that is used during specification verification measurements.
- The SG 5050 internal adjustments are performed at an ambient temperature of 20°C to 30°C.
- The SG 5050 must be in a noncondensing environment whose limits are described under Table 1-3, Environmental Specifications.
- Allow 30 minutes warm-up time for operation to specified accuracy; 60 minutes after exposure to or storage in high-humidity or condensing environment.

Items listed in the Performance Requirements column of the Electrical Specifications are verified by completing the Performance Check in this manual. Items listed in the Supplemental Information and Description columns are provided for user information only and should not be interpreted to be Performance Check Requirements.

NOTE

The SG 5050 has been designed in accordance with the intent of UL Standard 1244, "Safety Requirements for Electrical and Electronic Measuring and Test Equipment."

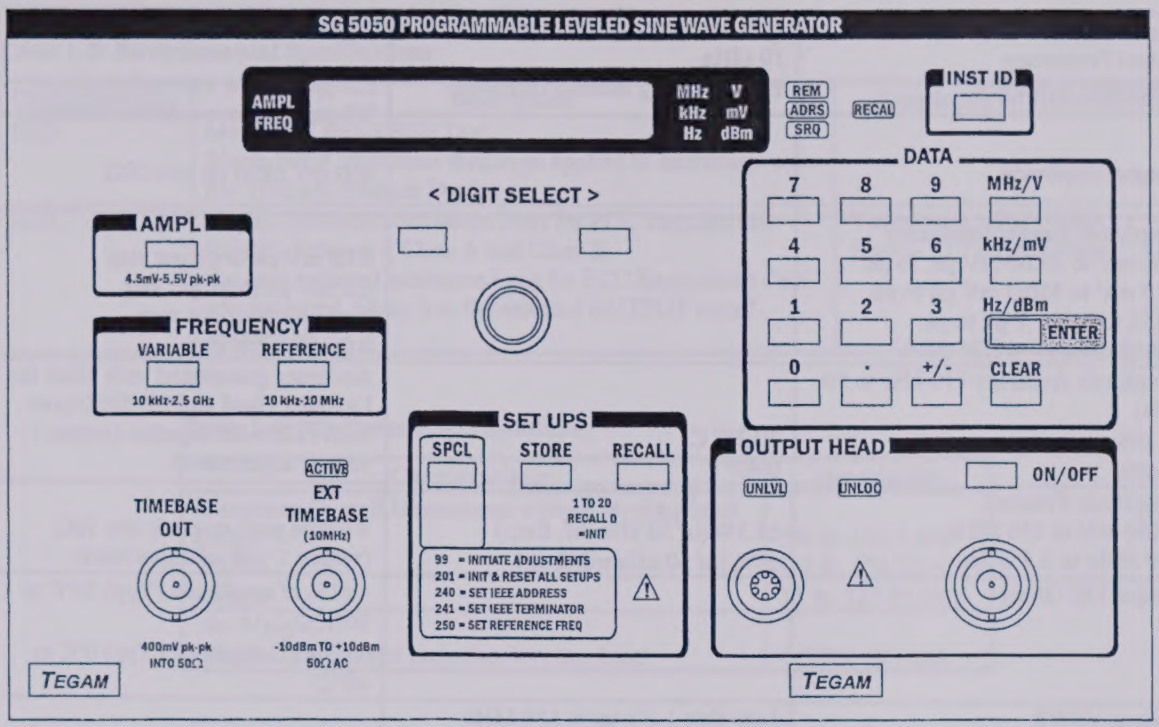


Table 1-2: Electrical Specifications

Characteristics	Performance Requirement	Supplemental Information
Frequency Range/Resolution		
10.000 kHz to 49.999 kHz		1 Hz steps
50.00 kHz to 549.99999 MHz		10 Hz steps
550.00000 MHz to 1.499 GHz		100 Hz steps
1.500 GHz to 2.500 GHz		1000 Hz steps
Frequency Accuracy		
Using Internal Timebase (within one year of last adjustment)		
10.000 kHz to 49.999 kHz	±(0.0003% of setting +0.3 Hz)	
50.00 kHz to 2.500 GHz	±(0.0003% of setting +3 Hz)	
Frequency Accuracy		1 ppm/year
Using External Timebase		
(10 MHz ±1.5 ppm)		
10.000 kHz to 49.999 kHz		±(external timebase error +0.3 Hz)
50.00 kHz to 2.500 GHz		±(external timebase error +3 Hz)
Input Amplitude Requirement		-10 dBm to +10 dBm (70 mV to 700 mV RMS)
Input Resistance		50Ω AC, 500Ω DC
Lock Time		Less than 3 seconds

Timebase Out Output Frequency Frequency Accuracy Output Amplitude	 10 MHz ±3 ppm (using internal timebase) 	 ±X ppm (using external timebase) Where X ppm is external timebase accuracy 400 mV pk to pk into 50Ω
Amplitude Range/Resolution 4.50 mV to 55.00 mV pk to pk 55.2 mV to 550.0 mV pk to pk 0.552 to 5.500 V pk to pk -42.95 dBm to +18.75 dBm		 0.02 mV pk to pk per step 0.2 mV pk to pk per step 2 mV pk to pk per step 0.05 dBm per step
Amplitude Accuracy (10 kHz to 50 kHz) ±1.5% ±3.0%	 20-26° C 0-40° C	Accuracy guaranteed only when the Leveling Head and SG 5050 have been calibrated together (within 1 year of adjustment).
Amplitude Flatness 50.00 kHz to 250 MHz 250 MHz to 2.5 GHz	 ±1.5% (of 50 kHz ref. freq.) ±4% (of 50 kHz ref. freq.)	 Voltage peak-to-peak into 50Ω (within 1 year of adjustment)
Output DC Offset		<±1% of amplitude (Vpp) 20°C to 30°C <±2% of amplitude (Vpp) 0°C to 40°C
Output VSWR	Less than 1.2:1 up to 550 MHz Less than 1.3:1 550 MHz to 2.5 GHz	
Spectral Purity 10 kHz to 49.999 kHz 50.00 kHz to 1.1 GHz at 5.5V Harmonics 1.1 GHz to 2.5 GHz at 3.33V 1.1 GHz to 2.5 GHz at 5.5V Nonharmonics Phase Noise	 Less than -30 dBc 2nd harmonic typ Less than -35 dBc 3rd harmonic typ Less than -40 dBc all others Less than -30 dBc 2nd harmonic Less than -35 dBc 3rd harmonic Less than -40 dBc all others Less than -25 dBc 2nd harmonic typ Less than -30 dBc 3rd harmonic typ Less than -40 dBc Less than -85 dBc/Hz at 10 kHz offset from 10 kHz to 800 MHz -70 dBc above 800 MHz	 All harmonics and spurs less than -40 dBc
GPIB Setting Time Output OFF to ON All other function changes		From trailing edge of GPIB EOI until sine wave output is stable <150 ms <80 ms

Table 1-3: Environmental Specifications

Characteristics	Description	Supplemental Information
ESD	Meets IEC 802-2 ESD Test. Meets 20kV maximum discharge applied to instrument case per TEGAM Product Design	
EMC	Within conducted emissions limit for FCC Regulations, Part 15, Subpart J, Class A and Class B. Exceeds radiated emissions limit for FCC Regulations Part 15, Subpart J, Class A at the selected OUTPUT signal frequency.	Tested with a TM 5006A, Option 15 Power Module

Table 1-4: Mechanical Specifications

Characteristics	Description
Maximum Overall Dimensions without leveling head	
Height	5.0 in. (12.7 cm)
Width	8.0 in. (20.32 cm)
Length	11 in. (27.94 cm)
Net Weight	
Standard Instrument including leveling head	6.5 lbs. (2.4 kg)

Section 2
Operating Instructions

Introduction

This section of the manual contains plug-in installation and removal instructions and describes the functions of the SG 5050 front panel controls, connectors, and indicators. Operator's familiarization information is also provided as an aid in understanding how to operate the SG 5050 under local (manual) control.

Complete information for programming the SG 5050 via the GPIB (General Purpose Interface Bus) is found in the Programming section of this manual.

Preparation for Use

The SG 5050 is calibrated and ready for use when received. The SG 5050 is designed to operate only in the TM 5000-series power modules. Make certain the line selector block on the power module is positioned correctly.

The SG 5050 must also have the Output Leveling Head installed before use. The leveling head is calibrated to match the SG 5050. The two cables from the leveling head connect to the two OUTPUT HEAD connectors on the lower right portion of the SG 5050 front panel.

Installation and Removal

CAUTION

To prevent possible damage to the SG 5050, turn off the power module before installing or removing the instrument. Do not use excessive force to install or remove.

Check to see that the plastic barriers on the interconnecting jacks of the selected power module compartments match the cutouts in the SG 5050 rear interface connectors. If they do not match, do not install the SG 5050 until the reason is investigated. When the units are properly matched, align the SG 5050 chassis with the upper and lower guides of the selected compartments. Push the SG 5050 chassis in and press firmly to seat the rear-interface connectors in the interconnection jacks. Connect the two cables from the leveling head to the two connectors labeled OUTPUT HEAD on the SG 5050 front panel. Apply power to the SG 5050 by turning on the power module.

To remove the SG 5050 from the power module, ensure that the power is off, pull out both the release latches (located on the lower front panel) until the interconnecting jacks disengage and the SG 5050 slides out.

Repackaging For Shipment

If the instrument is to be shipped by commercial transportation, we recommend that it be packaged in the original manner. The carton and packaging material in which your instrument was shipped should be saved and used for this purpose.

If the original package is not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton with 200-lbs. test strength and having inside dimensions at least six inches greater than the instrument dimensions.
2. Wrap the instrument with polyethylene sheeting or equivalent material to protect the finish.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on each side.
4. Seal the carton with shipping tape or with an industrial stapler.

Front Panel Controls, Connectors and Display

All controls necessary for local operation of the SG 5050 are located on the instrument front panel. Some pushbuttons illuminate to provide visual indication that associated functions are active. A brief description of these controls, connectors, and indicators follows. Refer to Figure 2-1.

1 Display Indicators

The SG 5050 uses seven-segment LEDs to display a numerical value up to eight digits. In addition, LED indicators in the left and right areas of the display window illuminate to indicate the selected function and parameter units of measure.

Function

The illuminated indicator at the left side of the readout display window defines the function. The two functions are:

AMPL Activated when the AMPL button is pressed.

FREQ Activated when the FREQUENCY VARIABLE or FREQUENCY REFERENCE button is pressed.

Parameter Units of Measure

The illuminated units indicator at the right side of the readout display window defines display value units. These units are:

MHz Activated when the FREQUENCY VARIABLE button is selected. Frequency selected is from 1 MHz to 2500 MHz.

kHz Activated when the FREQUENCY VARIABLE button is selected. Frequency selected is from 10.0 kHz to 999.99 kHz.

V Activated when the AMPL button is selected. Amplitude selected is from 1 V to 5.500 V.

mV Activated when the AMPL button is selected. Amplitude selected is from 4.5 mV to 998 mV.

dBm Activated when the AMPL button is selected. Amplitude selected is from -42.95 dBm to +18.75 dBm.

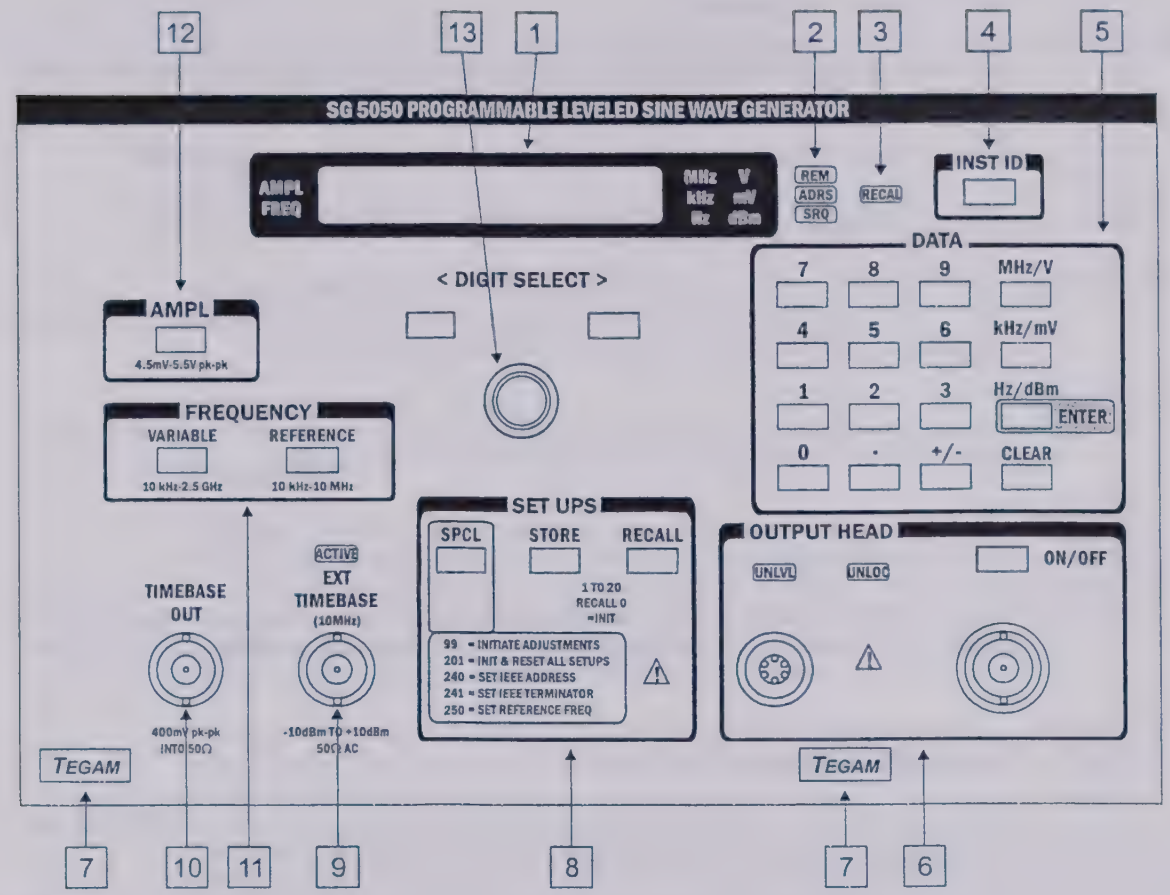


Figure 2-1: Front Panel Controls and Connectors

2 GPIB Status Indicators

The present status of the GPIB is shown by the illuminated indicators just to the right of the readout display window. They are:

REM Illuminates when the SG 5050 is operating under remote control via the GPIB.

ADRS Illuminates when the SG 5050 is addressed to 0-30 via the GPIB. The indicator turns off when GPIB address is set to 31.

SRQ Illuminates when the SG 5050 has detected an error or event. The controller must conduct a serial poll to query the error or event and to extinguish the SRQ indicator.

NOTE

At power-up the SRQ and ADRS indicators are lit. This may not indicate an error condition but only that the power-on SRQ has occurred and has not yet been serviced by a GPIB controller.

3 RECAL Indicator

Indicates the loss of the calibration constants. Most likely this is due to nonvolatile memory failure. This indicator remains lit until the instrument has been readjusted by performing the Adjustment Procedure in this manual.

4 INST ID Pushbutton

Causes the SG 5050 to display its primary GPIB address and message terminator. If USEREQ has been enabled, it generates a Service Request (SRQ) over the GPIB.

The message terminator presently selected in the SG 5050 (either EOI or LFEOI) is displayed in the readout display window.

See Section 3, Programming for instructions to change the GPIB address and to select the message terminator required by your controller.

5 DATA Entry Keypad

0 through 9, decimal point, +/-

Used to enter a numeric value for the amplitude, frequency, or the argument when using STORE, RECALL, or SPCL.

MHz/V, kHz/mV, Hz/dBm

Used to terminate the entry of a parameter value and specify the unit of measure after you have selected the amplitude or frequency function. The appropriate unit illuminates in the readout display window, indicating the selected unit.

ENTER

Used only with the front panel SET UPS, entry of the STORE/RECALL storage locations, and the SPCL pushbutton functions (for example, setting the GPIB address).

CLEAR

Used to delete a partial entry. The SG 5050 returns to the previous valid instrument settings.

Also used after STORE or RECALL is pressed to cancel the STORE or RECALL operation and reset the display.

6 OUTPUT HEAD

Connectors

The Output Leveling Head provides the connection between the SG 5050 and the Instrument-Under-Test. Within the leveling head are attenuators, signal level sense detectors, and precision impedance matching circuits. The leveling head must be used for all SG 5050 operations and should be connected directly to the load to maximize performance. The use of extension cables, matching networks, transformers, etc., between the leveling head and the Instrument-Under-Test can cause performance degradation due to transmission losses and reflections.

If extension cabling is absolutely necessary between the leveling head and the Instrument-Under-Test, coaxial air line is recommended to minimize frequency dependent losses that affect the apparent leveling performance.

Two cables connect the leveling head to the SG 5050. The N connector cable carries the output signal, and the multiwire cable carries control and status signals back to the SG 5050. If the multiwire cable is disconnected, the SG 5050 output automatically turns off. If only the N cable is disconnected, the SG 5050 signal may still be present at the front panel N but it is effectively removed from the Instrument-Under-Test.

The SG 5050 is adjusted and shipped from the factory with a matching leveling head. The serial number on the leveling head must match the SG 5050 serial number for calibrated operation. Do not interchange leveling heads between instruments, as performance may no longer be to specification. If the leveling head is interchanged, the complete calibration Adjustment Procedure must be performed before use.

ON/OFF Pushbutton

Disconnects the sine wave signal output from the leveling head. The output impedance at the signal output connector remains at 50Ω.

UNLVL Indicator

When illuminated, indicates the sine wave output is unleveled (for example, excessive loading, open signal or control line, leveling circuit failure, etc.).

UNLOC Indicator

When illuminated, indicates one of the frequency setting loops is not locked to the timebase reference frequency (for example, out-of-range reference signal, circuit failure, etc.).

7 Release Latches

Plug-in release latches. Pull both latches to remove the SG 5050 from the power module.

8 SET UPS

STORE Pushbutton

Stores the present instrument setting in the specified user-definable storage location. Twenty locations (1 through 20) are available. Instrument settings are retained in memory when the instrument is powered down.

RECALL Pushbutton

Recalls an instrument setting from user-specified storage locations (1 through 20) and configures the instrument to those settings. Recall 0 configures the instrument to factory-default settings that are the same as the INIT settings.

SPCL Pushbutton

Lets you initialize the present front panel settings and all 20 storage location setups at one time.

Allows you to set the GPIB address or message terminator from the front panel. See Section 3, Programming.

Allows you to set the reference frequency.

9 EXT TIMEBASE Connector

Allows the SG 5050 timebase to be frequency-locked to a precision external 10 MHz reference frequency.

ACTIVE Indicator

Indicates the external 10 MHz reference frequency signal has sufficient amplitude and approximately the correct frequency to lock the internal timebase.

10 TIMEBASE OUT Connector

Provides the internal 10 MHz timebase frequency output to frequency lock other signal sources to the SG 5050.

11 FREQUENCY

VARIABLE Pushbutton

Selects the variable frequency function. Lets you vary the sine wave output frequency, using the control knob or the DATA keypad. Frequency values can be selected in hertz, kilohertz, or megahertz.

The VARIABLE pushbutton and the FREQ indicator in the readout display window are illuminated when the VARIABLE function is active.

REFERENCE Pushbutton

Selects the variable reference frequency, and displays the reference frequency in the readout display window. To return to the variable frequency setting that was last selected, press the VARIABLE pushbutton.

The REFERENCE pushbutton and the FREQ indicator in the readout display window are illuminated when the REFERENCE function is active.

12 AMPL Pushbutton

Selects the variable amplitude function. Lets you vary the sine wave output amplitude using either the control knob or the DATA keypad. Amplitude values can be selected in volts, millivolts, or dBm.

The AMPL indicator in the readout display window and the AMPL button are illuminated when the amplitude function is active.

The amplitude can be set in either the REFERENCE or VARIABLE FREQUENCY mode and remains the same when switching between modes.

13 Control Knob

Varies the value of the selected parameter. The smallest rate of change (increment) of a digit is determined by the mode and range that you select. For example, if you are in the amplitude mode and have selected a value within the range of 0.552 V to 5.500 V, the readout increments or decrements in as small as 2 mV steps.

DIGIT SELECT Pushbuttons

Selects the control knob resolution (that is, the digit that changes when the control knob is rotated).

Each push of the left or right button causes the selected digit to blink as it steps one place left or right.

Rear Panel

The rear panel of the SG 5050 has a 4-position DIP switch that is used to configure the instrument at power-up. These switches are used to activate service functions and are not used under normal operation. Their function, however, is described briefly below.

For normal operation, all toggles are set for open contacts (the contacts are closed when the toggle is depressed to the left, facing the rear of the instrument).

The following functions are activated when the contacts are closed:

Toggle	Function
1	Reinitialize firmware
2	Diagnostic bypass
3	Enable adjustment
4	Not used

Operator Familiarization

General Operating Information

With the SG 5050 properly installed in the power module, allow 30 minutes warm-up time for operation to specified accuracy; 60 minutes after storage in or exposure to a high humidity (condensing) environment.

Power-Up Sequence

When powered up, the SG 5050 performs a diagnostic self-test to check the functionality of its ROM, RAM, and some hardware circuits. It also illuminates all front panel LEDs and indicators. If a self-test error is detected, an E followed by a 3-digit error code appears in the readout window indicating an internal malfunction. Should this occur, refer the condition to qualified service personnel. Pressing any button clears the error code from the readout window and allows the instrument to complete initialization, but does not clear the condition causing the error code. If more than one error has been detected, a button may have to be pushed several times to clear each of the errors in turn from the display.

Upon successful completion of the self-test, the SG 5050 restores the instrument settings that were in use when the instrument was last turned off. The sine wave signal to the output head, however, is always off at power-up.

In addition, the SG 5050 always powers up with the frequency displayed in the display window and with the control knob digit select resolution set to the default value.

Initializing the Instrument Settings

You can initialize the present front panel settings, or all 20 of the instrument setting storage locations at one time.

To initialize the present front panel settings:

1. Press the RECALL button.
2. Enter 0 (zero) on the DATA keypad.
3. Press the ENTER button.

The SG 5050 is now initialized to the following settings.

Output ON/OFF	OFF
AMPL	1.000 V
FREQUENCY	10.00000 MHz
Reference	OFF
Variable (10 kHz-2500 MHz)	ON
RQS	ON
USEREQ	OFF
SREFREQ	50.00 kHz

To initialize the present instrument setting and all 20 of the storage locations:

1. Press the SPCL button.
2. Enter 201 on the DATA keypad.
3. Press the ENTER button.

The instrument settings and all storage locations are now initialized to the settings listed above.

Function and Parameter Selection

The SG 5050 generates an amplitude-leveled sine wave signal with two variable functions, amplitude and frequency. The parameters of these two functions are set from the front panel using either the control knob or the DATA entry keypad (for GPIB operation, refer to Section 3, Programming). The ranges for each function and the parameter resolutions are specified in Section 1, Specifications of this manual.

Setting Amplitude Parameters

To select a specific amplitude value, press the AMPL button. The amplitude parameter and unit of measure last selected appears in the readout display window.

Voltage Resolution vs. Range

Voltage Range	Resolution
-42.96 dBm to +18.75 dBm	0.05 dBm
4.50 mV to 55.00 mV	0.02 mV
55.2 mV to 550 mV	0.2 mV
0.552 V to 5.500 V	2 mV

Next, enter the desired amplitude value using either the control knob or DATA entry keypad as follows:

Control Knob Entry

Press the DIGIT SELECT buttons to select the significant digit you wish to change (each digit blinks once when selected). Clockwise knob rotation increments the selected digit, and counterclockwise rotation decrements the selected digit.

DATA Keypad Entry

Select the numeric value first and then the units desired (for example, V, mV, or dBm) on the keypad; this action enters the selected amplitude value. If the amplitude value entered on the keypad has a higher resolution than is allowed, the SG 5050 rounds it off to the nearest allowable setting.

Setting Frequency Parameters

To select a specific frequency, press the VARIABLE FREQUENCY button. The frequency parameter and unit of measure last selected appears in the readout display window.

Frequency Resolution vs. Range

Frequency Range	Resolution
10.000 kHz to 49.999 kHz	1 Hz
50 kHz to 550.0000 MHz	10 Hz
550.0000 MHz to 1.500 GHz	100 Hz
1.500 GHz to 2.500 GHz	1000 Hz

Next, enter the desired frequency value using either the control knob or DATA keypad as follows:

Control Knob Entry

Press the DIGIT SELECT buttons to select the significant digit you wish to change (each digit blinks once when selected). Clockwise knob rotation increments the selected digit, and counterclockwise knob rotation decrements the selected digit.

DATA Keypad Entry

Select the numeric value first and then the units desired (for example, Hz, kHz or MHz) on the keypad; this action enters the selected frequency value. If the frequency value entered on the keypad has a higher resolution than is allowed, the SG 5050 rounds it off to the nearest allowable setting.

Table 2-1: Front Panel Error Codes

Error	Description
250	Not in adjustment mode
350	Unleveled
354	VCO Board PLL unlocked
355	DDS PLL unlocked
356	Unplugged
357	Head temperature error/leveling A/D error
363	Battery RAM error, store settings lost
364	EEPROM error, cal constants lost
365	CPU to DDS communication error
GPIB Only Errors	
103	Value not valid
151	Error in command or syntax error
205	Error in number, value out of range or a bad symbol
401	Power-on event
403	ID/User request
455	SRQ pending

Setting the Reference Frequency

Press the REFERENCE FREQUENCY button. The readout window displays the reference frequency value. You can set the reference frequency amplitude by selecting the AMPL button and entering the desired amplitude as described under Setting Amplitude Parameters above.

Select the VARIABLE FREQUENCY button to return to the previous variable frequency settings and to turn off the reference frequency. The amplitude is the same as the reference frequency amplitude.

Changing the Programmable Reference Frequency

The SG 5050 has a programmable reference frequency. To change the reference frequency, press the SPCL key, the digits 250, followed by the ENTER key. The SG 5050 then displays the present value of the reference frequency. Use the keypad to enter the new value, and press the kHz or MHz key to enter the new value. If the frequency value entered on the keypad has a higher resolution than is allowed, the SG 5050 rounds it off to the nearest allowable setting. The range is 10 kHz to 10 MHz.

Storing and Recalling Instrument Setups

You can store up to 20 instrument setups in battery backed-up nonvolatile RAM. To store a setup, set the instrument parameters and units of measure as desired, and press the STORE button. Enter a storage location between 1 and 20 on the DATA keypad, and press the ENTER button. The present instrument setup is now stored in that location (in nonvolatile RAM) and is retained when the instrument is powered down.

To recall a specific set of instrument settings, first press the RECALL button, enter any previously set storage location (1 through 20) on the DATA keypad, then press the ENTER button.

Displayed Errors

When powered up, the SG 5050 performs a diagnostic self-test to check its functionality. If an error is found, an error code is displayed in the display window. Pressing any key can clear the error. Error code definitions are listed in Table 2-1.

If no error is found during self-test, the SG 5050 restores the instrument settings that were in use when the instrument was last turned off, except the output is OFF.

Special Functions

The SG 5050 has several special functions that let you check or change operational settings. These functions are listed in Table 2-2.

To invoke an SPCL function, press the SPCL button. Then enter the two or three-digit SPCL code and press ENTER.

Output Loading

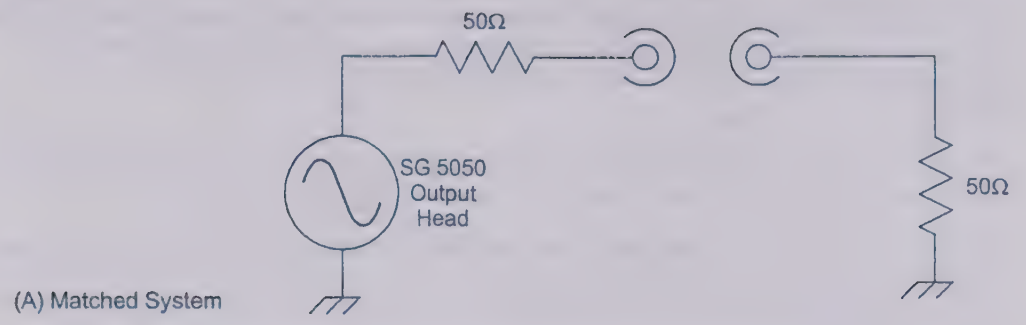
The SG 5050 is designed to operate into a 50Ω impedance load at the leveling head output connector. If load impedance is substantially greater than 50Ω, connect a low-loss, precision feed-through terminator of the appropriate value to the leveling head, and then make connection to the load. Refer to Figure 2-2(B) for reference.

NOTE

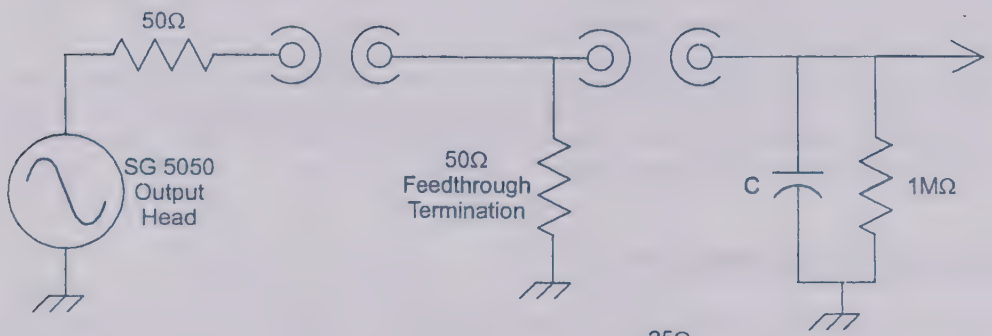
When lit, the UNLVL light on the front panel indicates a mismatched load or that the output is shorted. When the leveling head is disconnected from the front panel, the UNLVL light is also illuminated, and the instrument turns off its output.

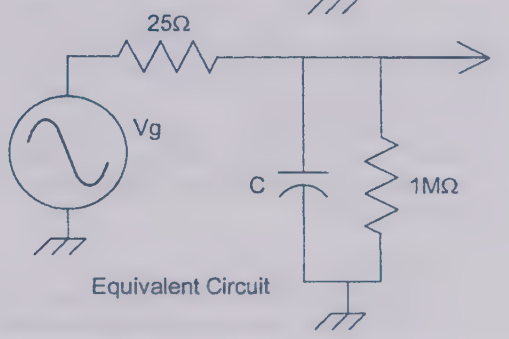
Table 2-2: Special Functions

Code	Description
99	This function initiates the instrument calibration process and is intended for use by qualified service personnel only. If the user accidentally selects this function, the instrument shows error code E250 (not in adjustment mode) in the display window, indicating the internal DIP switch toggles have not been set to allow adjustment.
201	Initializes the present front panel settings and all 20 storage location setups at one time. See Initializing the Instrument Settings earlier in this section.
240	Shows the present GPIB address in the display window, and lets you enter a new address from the keypad, if desired. See Resetting the GPIB Address and Message Terminator in Section 3, Programming.
241	Shows the presently selected message terminator in the display window, and lets you select either LFEOI or EOI. See Resetting the GPIB Address and Message Terminator in Section 3, Programming.
250	Allows the reference frequency to be set.



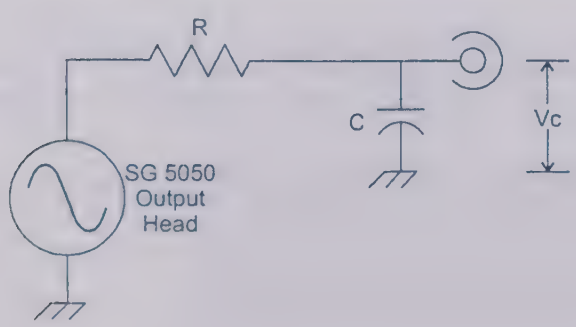
(A) Matched System





(B) Oscilloscope with High Input Impedance

Equivalent Circuit



$$Vc = \frac{Vg}{\sqrt{1 + \left(\frac{f}{f_{co}}\right)^2}}$$

Generator frequency is F and Fco is 1/(2πRC), the 3dB cutoff frequency. When the output head is terminated with a 50Ω feedthrough terminator, the value of R is 25Ω.

(C) Capacitive Load where Capacitance does not change with Frequency

Figure 2-2: Signal Termination Configurations

The SG 5050 adjusts signal amplitude at the leveling head. To maintain signal integrity, it is important to minimize adapter and transmission line discontinuities and reflections between the leveling head and the Instrument-Under-Test. Adding coaxial cable or other devices between the output head and the load impairs the constant amplitude function, since transmission line insertion losses vary with frequency.[1]

If there is a DC voltage across the load, use a DC blocking capacitor between the output head and the load. A DC blocking capacitor can be used with minimal loss at frequencies greater than 1 MHz.

A DC block is also useful as a protective device when the SG 5050 signal is applied to RF equipment that is sensitive to DC voltage, such as some spectrum analyzer inputs. Although the SG 5050 has no DC offset, it can output high amplitude low frequency AC signals that might be a problem to some sensitive RF circuits.

If signal amplitudes less than the minimum (4.5 mV p-p) are desired, use appropriate attenuators connected between the leveling head and the Device-Under-Test.

When operating the SG 5050, always consider the total load impedance and its effect on the output amplitude. The input capacitance of the equipment under test affects the bandwidth. The equivalent circuit shown in Figure 2-2 is useful in estimating the amplitude changes caused by capacitive loads. Note that as system input capacitance increases, output signal decreases.

Making Bandpass Measurements

Making bandpass measurements are easy with the SG 5050. Basically, a reference amplitude at the device-under-test output is set at a reference frequency, then the SG 5050 frequency is increased (or decreased) until the device-under-test output decreases by 3 dB (29.3%) from the reference amplitude. This is shown graphically in Figure 2-3. It is important that the reference amplitude be set at a frequency where the device-under-test is known to be linear. For most devices, the 50 kHz reference frequency of the SG 5050 is valid, though other frequencies may be used. An oscilloscope whose bandwidth is substantially greater than the device-under-test makes an ideal measurement device for bandwidth checks.

1. Connect the oscilloscope to the output of the device-under-test (DUT). To make the bandwidth measurement, set the reference frequency amplitude first. Adjust the SG 5050 output amplitude, the DUT gain, and the oscilloscope controls to display a sine wave of exactly six divisions, as shown in Figure 2-4.

2. Next, slowly increase (or decrease) the SG 5050 frequency until the oscilloscope display is reduced to 4.2 divisions, as shown in Figure 2-5. Letting the oscilloscope trigger to free-run might make the display amplitude easier to judge. Do not adjust the gain or amplitude controls during this step.

3. Check the SG 5050 frequency readout display. This is the -3dB frequency of the DUT.

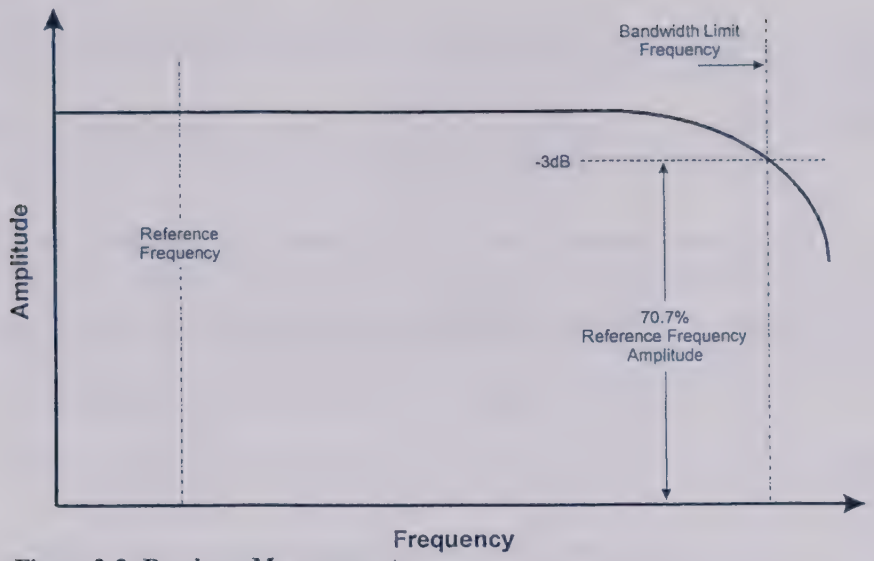


Figure 2-3: Bandpass Measurement

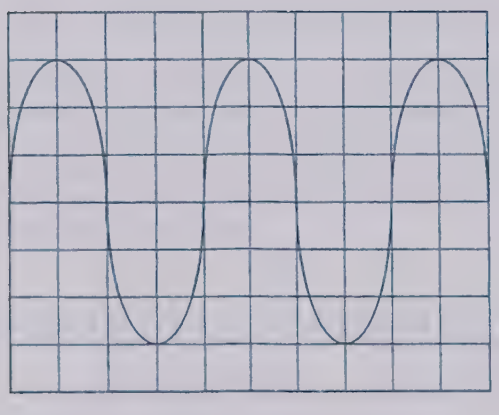


Figure 2-4: Reference Setup (6 Divisions)

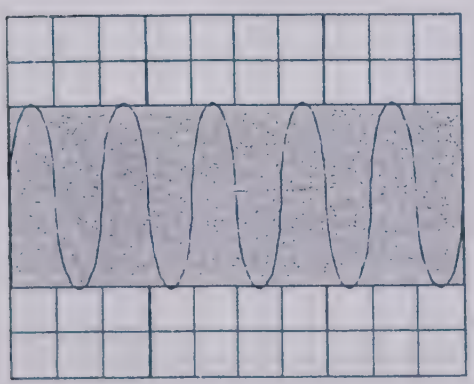


Figure 2-5: The –3dB Point (4.2 Divisions)

In some applications, a wide bandwidth DVM can be substituted for the oscilloscope. The following procedure may be used:

1. Connect the DVM to the output of the DUT. Set the reference frequency amplitude first. Adjust the SG 5050 output amplitude and the DUT gain to show some convenient value on the DVM, such as 1 V.

2. Next, slowly increase (or decrease) the SG 5050 frequency until the DVM reading is 70.7% of the reference amplitude. Do not adjust the gain or amplitude controls during this step.

3. Check the SG 5050 frequency readout display. This is the -3dB frequency of the DUT.

Section 3
Programming

Introduction

This manual section provides the information required for programming the TEGAM SG 5050 Leveled Sine Wave Generator through the IEEE-488 bus, commonly called the General Purpose Interface Bus (GPIB). The IEEE-488 bus interface is specified and described in the IEEE Standard 488.1-1987, Standard Digital Interface for Programmable Instrumentation. (Published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017.)

The information in this section assumes that the reader is knowledgeable in IEEE-488 bus communication and has some experience in programming a system that uses a GPIB-style interface.

All TEGAM programmable TM 5000 instruments are designed to communicate with any controller that can send and receive ASCII messages (commands) over the IEEE-488 bus. The instruments are connected to the IEEE-488 bus through a TM 5000 power module. Refer to the Operating Instructions section of this manual for information on installing the SG 5050 in the power module. Also, it is helpful to review that section and become familiar with front panel functions.

Commands for TM 5000 programmable instruments either alter instrument settings or request information from the instrument. The command set for each instrument is designed for compatibility among TM 5000 instrument types. When possible, the same commands are used in different instruments to control similar functions. In addition, commands are specified in mnemonics that are related to the functions implemented. For example, the INIT command initializes instrument settings to predefined default settings.

IEEE-488 Interface Function Subsets

The SG 5050 IEEE-488 interface is based on the IEEE-488.1-1987 interface (described above).

Table 3-1 shows the compatibility of SG 5050 operation with these combined standards.

Table 3-1: IEEE-488 Interface Function Capability

Function	Subset	Capability
Source Handshake	SH1	Complete capability
Acceptor Handshake	AH1	Complete capability
Basic Talker	T6	Responds to serial poll. Untalks if My Listen Address (MLA) is received.
Basic Listener	L4	Unlistens if My Talk Address (MTA) is received.
Service Request	SR1	Complete capability
Remote-Local	RL1	Complete capability
Parallel Poll	PP0	Does not respond to parallel poll
Device Clear	DC1	Complete capability
Device Trigger	DT0	Does not respond to GET
Controller Function	C0	No controller function

GPIB Address and Message Terminator

The SG 5050 primary GPIB address can be set to any decimal number in the range 0 to 31. Address 31 effectively removes the SG 5050 from the bus, though it remains an electrical load. When the GPIB address is set to 31, the ADRS indicator will be off. The SG 5050 is shipped with the GPIB address set to 10.

The SG 5050 responds to one of two possible message terminators (LF and EOI or EOI only). The message terminator must match that required by the controller. The SG 5050 is shipped with the message terminator set to EOI only. The message terminator and the primary GPIB address are stored in nonvolatile RAM memory.

The front panel SPCL button allows the present GPIB primary address and message terminator to be displayed on the SG 5050 readout. To display the GPIB address, press the SPCL button, enter 240 from the keypad, and press ENTER. The address is then displayed, for example, `GPIB 10`. Pressing the ID button also displays the GPIB address.

To display the message terminator, press the SPCL button, enter 241 from the keypad, and press ENTER. The letters `LF EOI` are then displayed if the selected message terminator is LF EOI, and the letters `EOI` are displayed if the terminator is EOI only.

Resetting the GPIB Address and Message Terminator

The SPCL button can also be used to change the GPIB primary address and the message terminator. To reset the GPIB address, perform the following operation:

1. Press SPCL.
2. Enter 240 from the keypad.
3. Press ENTER.
4. After present GPIB address setting is displayed, enter the new address from the keypad.
5. Press ENTER.

To reset the message terminator, perform the following operation:

1. Press SPCL.
2. Enter 241 from the keypad.
3. Press ENTER.
4. After present message terminator is displayed, use the knob to select the new terminator.
5. Press ENTER.

Commands

The SG 5050 is controlled either by front panel controls or by remote commands that it receives from the controller through the GPIB interface. The remote commands are divided into three types:

- **Setting commands** – Control instrument settings.
- **Query/Output commands** – Request data.
- **Operational commands** – Change instrument operational commands (store, test, etc.).

When the instrument is in the remote state, it executes all three types of commands in the appropriate manner (for example, sets an instrument control or returns the requested data). In the local state (that

is, when the instrument is under front panel control), the instrument only executes query/output commands.

In the following sections, the SG 5050 commands are presented in three ways:

- **Command Summary** – A command list divided into functional groups, with brief descriptions of each command.
- **Control/Command Descriptions** – A front panel illustration showing command relationships to front panel operation and internal parameters.
- **Detailed Command Descriptions** – An alphabetically arranged presentation of all the commands with complete detailed descriptions.

Command Format

A command consists of a header, and if necessary, one or more arguments. The command headers are English-language words that denote the operation to be carried out, such as INIT (initialize the instrument), or FREQUENCY (set the output signal frequency). Only the first three characters of a command header must be given, although it is acceptable to enter the entire command header.

When a command requires arguments, enter them after the command header. For example, the FREQUENCY command requires an argument to give the desired frequency setting (`FRE 15000`). A space character generally separates the header and arguments, although the command is accepted without the space.

The headers for query commands include a terminating question mark (?) symbol (`USEREQ?`). Since only the first three characters of a command header must be given, the ? may be given after these characters (for example, (`USE?`).

Additional information about the command format is given in the section titled Message Format.

Command Summary

This section provides a summary of the SG 5050 commands. The list is arranged in functional groups: instrument commands, status commands and system commands.

NOTE

Capitalized letters in the command header word are required characters; the lower case characters may be optionally entered. Angle brackets < > indicate a required user supplied element. Square brackets [ ] indicate an optional element.

Instrument Commands

The following commands control front panel operations:

`AMPlitude <num> [:<dBm>]` – Sets the amplitude of the output signal in volts. If desired, dBm can be selected.
`AMPlitude?` – Returns the present amplitude setting.

`FREquency <num>` - Sets the frequency of the output signal.

SREFreq <num> – Sets the value of the reference frequency.
FREquency? – Returns the present frequency setting.

REFreq ON – Turns on the 50 kHz reference frequency and sends it to the output.
REFreq OFF – Turns off the 50 kHz reference frequency and enables the variable frequency controls.
REFreq? – Returns the present status of the reference frequency (REFREQ ON or OFF).

OUTput ON – Turns on the output.
OUTput OFF – Turns off the output.
OUTput? – Returns the present status of the output (OUTPUT ON or OFF).

STOre <num> - Stores the present front panel setup at location 1 to 20.
RECall <num> - Recalls the front panel setup from location 0 to 20. (Location 0 contains the initialization settings.)

Status Commands

The following commands enable and disable service requests and return status information about instrument operation:

RQS ON – Enables generation of service requests.
RQS OFF – Disables generation of service requests.
RQS? – Returns status of service requests (RQS ON or OFF).

USEreq ON – Enables SRQ operation when the ID button is pushed.
USEreq OFF – Disables SRQ operation when the ID button is pushed.
USEreq? – Returns status of user request (USEREQ ON or OFF).

LEVeled? – Returns present status of output signal (LEVELED YES or NO).

EXTtb? – Returns present status of the external timebase input (EXTTB ACTIVE or INACTIVE).

System Commands

The following commands perform system wide operations:

ID? – Returns instrument identification and firmware version.

INIt – Initializes instrument settings.

SET? – Returns the present instrument settings to the GPIB interface. This command can be used for storage of setups on the host controller for later retrieval. It can also be used during development of an automated test procedure by allowing the host controller to "learn" a series of manual front panel settings.

TESt – Initiates a self-test on the instrument. When the test is complete, the instrument returns to the settings last entered. If the self-test fails, the SG 5050 returns an SRQ to the controller.

EVEnt? or ERRor? – Returns information about the event reported in the last serial poll.

HELp? – Returns a list of all the command headers the SG 5050 accepts.

`ABStouch <nrl>` - Provides a means of remotely activating (touching) front panel buttons and controls through the GPIB interface. Refer to Table 3-2.

Control/Command Descriptions

Figure 3-1 shows the instrument commands and their relationship to the front panel controls.

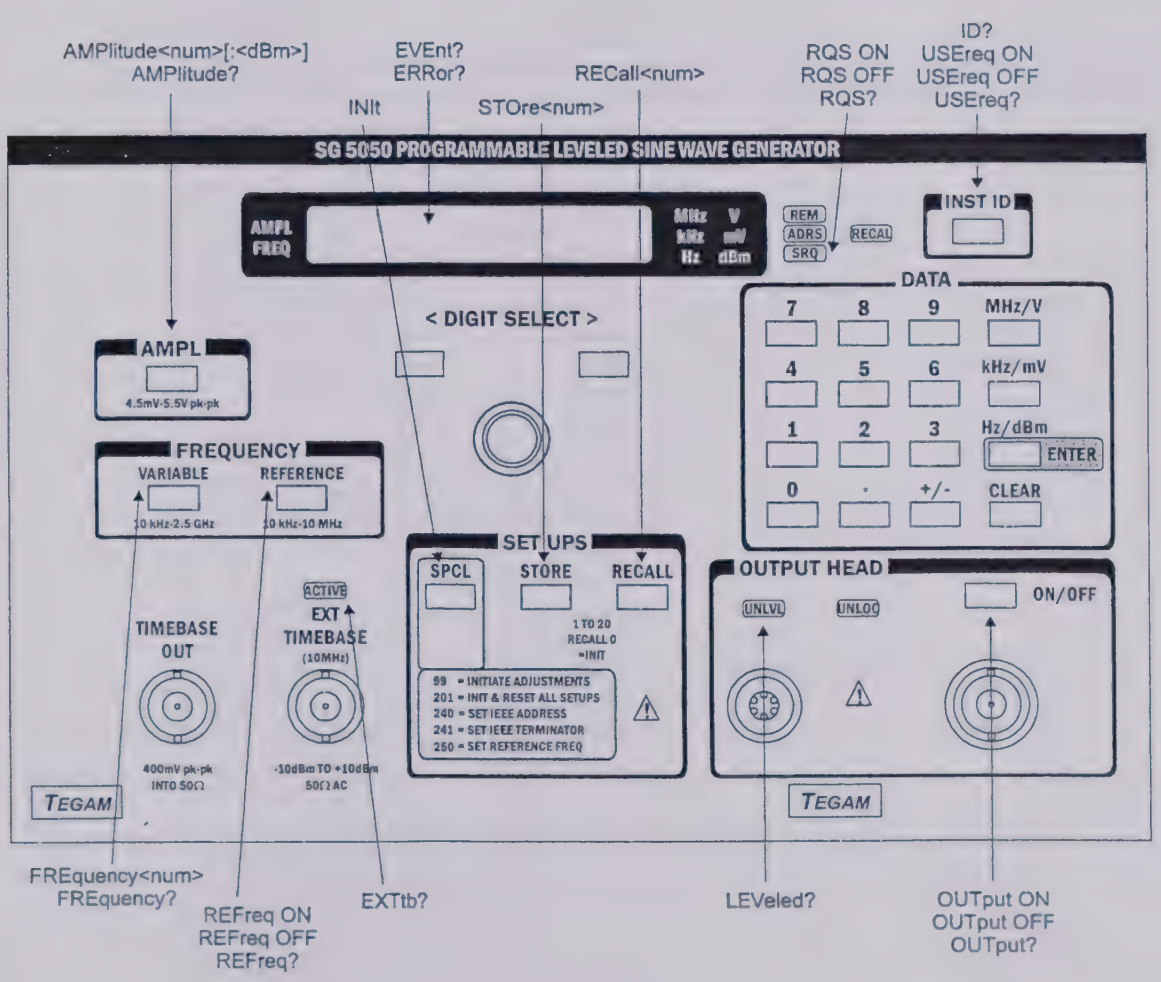


Figure 3-1: Instrument Commands and Front Panel Controls

Detailed Command List

The following section provides a detailed description of the SG 5050 commands and their command syntax.

NOTE

Capitalized letters in the command header word are required characters; the lower case characters may be optionally entered. Angle brackets < > indicate a required user supplied element. Square brackets [ ] indicated an optional element.

ABSTOUCH

Type Setting

Setting Syntax `ABStouch <nrl>`

Examples
```
ABSTOUCH 5
ABS 5
```

Discussion

This command causes one or more front panel buttons or controls to be remotely activated (touched) through the GPIB interface. This feature is useful for evaluation and applications procedures that simulate operator actions.

Table 3-2: ABSTOUCH Command Arguments

Front Panel Switch Function	Argument (decimal number)
Knob Increment	0
Knob Decrement	1
Output ON	2
CLEAR	3
0	4
.	5
+/-	6
Hz/dBm/ENTER	7
1	8
2	9
3	10
kHz/mV	11
4	12
5	13
6	14
MHz/V	15
7	16
8	17
9	18
INST ID	19
AMPLITUDE	20
VARIABLE	21
STORE	22
SPCL	23
<	24
>	25
REFERENCE	26
RECALL	27

AMPLITUDE

Type Setting or query

Setting Syntax

```
AMPlitude <num> [:dBm]
```

Examples

	Amplitude Selected
`AMPLITUDE 4.5`	4.5 V p-p
`AMPL .5`	500 mV p-p
`AMP 3.5E-2`	35 mV p-p
`AMP 0:dBm`	0 dBm
`AMP -30:dBm`	-30 dBm

Query Syntax

```
AMPlitude?
```

Query Response Syntax

```
AMPLITUDE <num>
AMPLITUDE <num> :dBm
```

Query Response Examples

```
AMPLITUDE 3.250
AMPLITUDE 400.OE-3
AMPLITUDE -15.00:DBM
```

Discussion

This command sets the amplitude of the output signal in volts peak-to-peak or dBm. If dBm units are not specified, volts are assumed. The dBm range is –42.95 dBm to +18.75 dBm, with a resolution of 0.05 dBm. The voltage peak-to-peak range of the instrument is 4.50 mV to 5.500 V. This range is divided into three subranges, and the amplitude resolution is different in each of these subranges as follows:

Range	Resolution
-42.95 dBm to +18.75 dBm	0.05 dBm
4.50 mV to 55.00 mV	0.02 mV
55.2 mV to 550.0 mV	0.2 mV
0.552 V to 5.500 V	2 mV

If the amplitude specified in the command has a greater resolution than the subrange it falls in, the amplitude is rounded off to the closest allowable resolution.

The `AMPlitude?` command causes the present amplitude setting to be returned.

ERROR?
EVENT?

Type Query

Query Syntax
```
ERRor?
EVEnt?
```

Query Response Syntax
```
ERROR <num>
EVENT <num>
```

Query Response Examples
```
ERROR 205
EVENT 351
```

Discussion

These commands return information about the event reported in the last serial poll. If RQS is ON, the <num> response for both commands is the event code for the last reported status byte. If RQS is OFF, <num> is the event code for the highest priority event that occurred. The event code is cleared upon completion of these commands. Refer to the section titled Status and Error Reporting for a discussion of event codes and status bytes. Table 3-4 lists all the SG 5050 error/event codes.

These two commands are equivalent and either can be used to preserve compatibility with other TEGAM GPIB products.

EXTTB?

Type Query

Query Syntax
```
EXTtb?
```

Query Response
```
EXTTB ACTIVE
```
or
```
EXTTB INACTIVE
```

Discussion

This command returns the present status (ACTIVE or INACTIVE) of the external timebase input (EXT TIMEBASE) connector).

FREQUENCY

Type Setting or query

Setting Syntax `FREquency <num>`

Examples
```
FREQUENCY 120E3
FREQ 1.5E4
FRE 5E+4
```

Query Syntax `FREquency?`

Query Response Syntax `FREQUENCY <num>`

Query Response Examples
```
FREQUENCY 125.00E+3
FREQUENCY 10.000E+3
```

Discussion

This command sets the frequency of the output signal. The frequency range of the instrument is 10 kHz to 2.500 GHz. This range is divided into four subranges, and the frequency resolution is different in each of these subranges as follows:

Range	Resolution
10.000 kHz to 49.999 kHz	1 Hz
50.00 kHz to 550.00000 MHz	10 Hz
550.00000 MHz to 1.500 GHz	100 Hz
1.500 GHz to 2.500 GHz	1000 Hz

HELP?

Type Query

Query Syntax `HELp?`

Query Response
```
HELP ABSTOUCH,AMPLITUDE,CAL,ERROR,EVENT,
EXTTB,FREQUENCY,HELP,ID,INIT,LEVELED,OUTPUT,
RECALL,REFREQ,RQS,SET,SREFREQ,STORE,TEST,
USEREQ
```

Discussion

This command returns the word `HELP` followed by a list of all the command headers the SG 5050 accepts.

ID?

Type Query

Query Syntax `ID?`

Query Response `ID TEGAM/SG5050,Vxx.x,Fx.x`

Discussion

This command returns the instrument identification and the firmware version as follows:

TEGAM/SG5050 – Identifies the instrument type.

Vxx.x – Identifies the version of the TEGAM main processor firmware.

Fx.x – Identifies the instrument's RF deck processor firmware version. For example, F1.0 indicates the firmware version 1.0.

INIT

Type System

Setting Syntax `INIt`

Example `INIT`

Discussion

The INIT command clears the current settings and initializes the SG 5050 to the following predefined settings:

```
OUTPUT OFF
AMPLITUDE 1.000
FREQUENCY 1.00000E+7
REFREQ OFF
RQS ON
USEREQ OFF
SREFREQ 50.0E6
```

After the SG 5050 has executed the `INIT` command, the display shows FREQ 10.00000 MHz, and the switch button VARIABLE is illuminated. (No other switches are illuminated.)

This command has the same effect as the `RECALL 0` command. Neither of these commands affects the UNLVL or EXT TIMEBASE Active LED. The stored settings buffer is not affected.

LEVELED?

Type Query

Query Syntax `LEVeled?`

Query Response
```
LEVELED YES
or
LEVELED NO
```

Discussion

This command returns the leveled-signal status of the output signal (YES or NO).

OUTPUT

Type Setting or query

Setting Syntax
```
OUTput ON
OUTput OFF
```

Examples
```
OUTPUT ON
OUTPUT OFF
```

Query Syntax `OUTput?`

Query Response
```
OUTPUT ON
or
OUTPUT OFF
```

Discussion

This command turns the signal output on or off at the OUTPUT HEAD connectors, depending on the argument specified. The source impedance is maintained when the output is off. At power-up, the output is set to OFF.

The `OUTput?` command returns the present status of the output signal (ON or OFF).

RECALL

Type Operational

Syntax
```
RECall
```

Examples
```
RECALL 2
REC 7
REC 0
```

Discussion

This command recalls the instrument settings from the nonvolatile RAM location specified in the <num> argument and sets the instrument to those settings. The <num> argument can be from 0 to 20 (decimal). Numbers 1 through 20 are used for user-selectable setups; number 0 references the initialization setup (that is, the `RECALL 0` command is equivalent to the INIT command). If no settings are stored in the specified location, the instrument assumes the `INIT` command settings.

REFREQ

Type Setting or query

Setting Syntax
```
REFreq ON
REFreq OFF
```

Query Syntax
```
REFreq?
```

Query Response
```
REFREQ ON
```
or
```
REFREQ OFF
```

Discussion

This command turns the reference frequency ON and OFF. When the reference frequency is ON, the variable frequency controls are disabled and the reference frequency is connected to the output. When the reference frequency is OFF, the variable frequency controls are enabled and control the frequency of the output signal. The output frequency is returned to the previous variable frequency. The output amplitude remains at its last setting.

The `REFreq?` command returns the present status of the reference frequency (ON or OFF).

RQS

Type Setting or query

Setting Syntax
```
RQS ON
RQS OFF
```

Query Syntax
```
RQS?
```

Query Response
```
RQS ON
```
or
```
RQS OFF
```

Discussion

This command enables and disables the instrument's ability to generate service requests (SRQs). When RQS (request for service) is ON, the instrument asserts an SRQ on the GPIB whenever an event occurs that requires a service request. The events that normally cause service requests to be asserted include the power-up sequence, self-test errors, front panel operation errors, programming errors, and internal errors.

When RQS is OFF, SRQs are saved, and the SRQ annunciator light on the instrument front panel is lit. An ERROR? or EVENT? command query can then be used to determine which SRQs have been generated.

The RQS? command returns the present status of the SRQ function (ON or OFF).

SET?

Type Query

Query Syntax
```
SET?
```

Query Response Example
```
OUTPUT ON; AMPLITUDE 17.40E-3; FREQUENCY
123.34543E+6; REFREQ OFF; RQS ON; USEREQ
OFF; SREFREQ10.00000E6
```

Discussion

This command returns the present instrument settings for OUTPUT (ON or OFF), AMPLITUDE, FREQUENCY, REFREQ (ON or OFF), RQS (ON or OFF), USEREQ (ON or OFF), and the value of the reference frequency. The maximum length of the settings query data string is 103 bytes.

SREFREQ

Type	Setting or Query
Setting Syntax	`SREfreq <num>`
Examples	`SREFREQ 1.0E6` `SREF 1.5E4`
Query Syntax	`SREfreq?`
Query Response Syntax	`SREFREQ <num>`
Query Response Examples	`SREFREQ 50.00E3` `SREFREQ 4.00000E6`

Discussion

This command sets the frequency of the output signal when the reference frequency is active. The frequency range of the reference signal is 10 kHz to 10 MHz. The frequency resolution is the same as the frequency setting for each subrange.

STORE

Type	Operational
Syntax	`STOre <num>`
Examples	`STORE 8` `STO 13`

Discussion

This command causes the present instrument front panel control settings to be stored in nonvolatile RAM at a location specified with the <num> argument. The <num> argument can be from 1 to 20 (decimal). Twenty front panel control settings are saved for each instrument setup. Nonvolatile RAM is provided so that the settings are saved when power is turned off to the instrument.

TEST

Type	Operational
Syntax	`TESt`
Example	`TEST`

Discussion

This command causes the instrument to perform a self-test. When the test completes, the instrument returns to the settings last entered. If the self-test fails, the SG 5050 returns an SRQ to the controller.

USEREQ

Type	Setting or query
Setting Syntax	`USEreq ON` `USEreq OFF`
Examples	`USEREQ ON` `USEREQ OFF`
Query Syntax	`USEreq?`

Query Response	`USEREQ ON`
	or
	`USEREQ OFF`

Discussion

This command enables or disables the SRQ interrupt that is generated when the front panel INST ID button is pressed. When the `USEREQ` (user request) function is OFF, the instrument is inhibited from returning the instrument ID SRQ when the INST ID button is pressed.

The `USEreq?` command returns the present status of the instrument ID SRQ (ON or OFF).

B7 B6 B5 / BITS B4 B3 B2 B1	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 NUL 0 0	20 DLE 16 10	40 SP 32 20	60 0 48 30	100 @ 64 40	120 P 80 50	140 ` 96 60	160 p 112 70
0 0 0 1	1 GTL SOH 1 1	21 LLO DC1 17 11	41 ! 33 21	61 1 49 31	101 A 65 41	121 Q 81 51	141 a 97 61	161 q 113 71
0 0 1 0	2 STX 2 2	22 DC2 18 12	42 " 34 22	62 2 50 32	102 B 66 42	122 R 82 52	142 b 98 62	162 r 114 72
0 0 1 1	3 ETX 3 3	23 DC3 19 13	43 # 35 23	63 3 51 33	103 C 67 43	123 S 83 53	143 c 99 63	163 s 115 73
0 1 0 0	4 SDC EOT 4 4	24 DCL DC4 20 14	44 $ 36 24	64 4 52 34	104 D 68 44	124 T 84 54	144 d 100 64	164 t 116 74
0 1 0 1	5 PPC ENQ 5 5	25 PPU NAK 21 15	45 % 37 25	65 5 53 35	105 E 69 45	125 U 85 55	145 e 101 65	165 u 117 75
0 1 1 0	6 ACK 6 6	26 SYN 22 16	46 & 38 26	66 6 54 36	106 F 70 46	126 V 86 56	146 f 102 66	166 v 118 76
0 1 1 1	7 BEL 7 7	27 ETB 23 17	47 ' 39 27	67 7 55 37	107 G 71 47	127 W 87 57	147 g 103 67	167 w 119 77
1 0 0 0	10 GET BS 8 8	30 SPE CAN 24 18	50 (40 28	70 8 56 38	110 H 72 48	130 X 88 58	150 h 104 68	170 x 120 78
1 0 0 1	11 TCT HT 9 9	31 SPD EM 25 19	51) 41 29	71 9 57 39	111 I 73 49	131 Y 89 59	151 i 105 69	171 y 121 79
1 0 1 0	12 LF A 10	32 SUB 26 1A	52 * 42 2A	72 : 58 3A	112 J 74 4A	132 Z 90 5A	152 j 106 6A	172 z 122 7A
1 0 1 1	13 VT B 11	33 ESC 27 1B	53 + 43 2B	73 ; 59 3B	113 K 75 4B	133 [91 5B	153 k 107 6B	173 { 123 7B
1 1 0 0	14 FF C 12	34 FS 28 1C	54 , 44 2C	74 < 60 3C	114 L 76 4C	134 \ 92 5C	154 l 108 6C	174 | 124 7C
1 1 0 1	15 CR D 13	35 GS 29 1D	55 - 45 2D	75 = 61 3D	115 M 77 4D	135] 93 5D	155 m 109 6D	175 } 125 7D
1 1 1 0	16 SO E 14	36 RS 30 1E	56 . 46 2E	76 > 62 3E	116 N 78 4E	136 ^ 94 5E	156 n 110 6E	176 ~ 126 7E
1 1 1 1	17 SI F 15	37 US 31 1F	57 / 47 2F	77 ? UNL 63 3F	117 O 79 4F	137 _ UNT 95 5F	157 o 111 6F	177 DEL 127 7F
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS (PPE)	(PPD)

KEY: octal 25 PPU / NAK — GPIB CODE / ASCII character; hex 15 / 21 — decimal

Figure 3-2: ASCII Character Chart

Messages and Communication Protocol

Command Separator

A message consists of a command or a series of commands followed by a message terminator. Messages consisting of multiple commands must have the commands separated by semicolons. A semicolon at the end of a message is optional. For example, each line below is a message:

```
INIT

INIT;RQS ON;USER OFF;ID?;SET?

init;
```

Message Terminator

Messages can be terminated with EOI (the GPIB End-Or-Identify signal) or the ASCII line feed (LF) character. Some controllers assert EOI concurrently with the last data byte; others use only the LF character as a terminator. The SG 5050 can be set via the front panel to accept either terminator.

With EOI only selected as the terminator, the instrument interprets any data byte received with EOI asserted as the end of an input message; it also asserts EOI concurrently with the last byte of an output message. With LFEOI selected as the terminator, the SG 5050 interprets either an LF character or EOI as a message terminator. Here, the instrument interprets the LF character without EOI asserted (or any data byte received with EOI asserted) as the end of an input message. To terminate output messages, the instrument transmits a carriage return (CR) followed by an LF character with EOI asserted. The SG 5050 is shipped with EOI only selected.

Formatting a Message

Commands sent to the SG 5050 must have the proper format (syntax) to be understood, however, this format is flexible in that variations are acceptable. The following describes this format and the acceptable variations.

The instrument expects all commands to be encoded in ASCII, however, it accepts both upper and lower case ASCII characters. All data output is in upper case (see Figure 3-2).

As previously discussed, a command consists of a header followed, if necessary, by arguments. A command with arguments may have a header delimiter, which consists of the space character (SP) between the header and the argument.

The SG 5050 ignores extra formatting characters SP that are added between the header delimiter and the argument, as shown in the following examples. (In these examples, the formatting characters are shown inside parentheses.)

Example 1: `RQS(SP)ON;`

Example 2: `RQS(SPSP)ON;`

Example 3: `RQSON`

In general, these formatting characters are ignored after any delimiter and at the beginning and end of a message:

- (SP)RQS(SP)ON(CRLF)
- (SP)USER(SP)OFF

Number Formats

The SG 5050 recognizes the following three number formats:

- **NR1 (integer)** – Signed or unsigned decimal integers (for example, +0, -0, +1, 2, -1, -10).
- **NR2 (real)** – Signed or unsigned decimal real numbers (for example, -3.2, +5.0, .2).
- **NR3 (floating point)** – Floating point numbers expressed in scientific notation (for example, +1.0E-2, 1.47E1, 1.E-2, 0.01E+0).

In each of these formats, an unsigned value is interpreted as a positive value (that is, 2 is equivalent to +2).

Rounding of Numeric Arguments

The SG 5050 rounds numeric arguments to the nearest unit of resolution and then checks for out-of-range conditions. If the argument is outside the allowable range, the instrument sets the value to the highest (or lowest) allowable value within the range. For example, if a frequency of 2600 MHz is given, the instrument frequency is set to 2500 MHz, the maximum allowable frequency and an error 205 (argument out of range) is generated.

Message Protocol

As the SG 5050 receives a message it is stored in the input buffer, processed, and executed. Processing a message consists of decoding commands, detecting delimiters, and checking syntax. If an error is detected during processing, the instrument asserts SRQ.

Executing a message consists of performing the actions specified by its command(s). For setting commands, this involves updating the instrument settings. The setting commands are executed in order received. Execution of the settings occurs when the instrument has received enough characters of the command to determine a valid setting. The instrument requires a message terminator to execute a valid command.

The SG 5050 behaves the same regardless of whether each command is sent as a separate message or several commands are included in one message. The only difference is that multiple-command messages require less bus overhead. When the SG 5050 receives a query/output command in a message, it executes the command by retrieving the appropriate data and putting it in the output buffer.

The instrument then continues to process and execute the remainder of the commands in the message. The query data is sent to the controller when the SG 5050 is made a talker.

NOTE

It is not recommended that multiple queries be placed in one message. If more than one query is in a message, one or more response(s) may be lost. No error message will be generated.

Multiple Messages

The SG 5050 input buffer has finite capacity and a single message may be long enough to fill it. In this case, the instrument processes the first portion of the message before the instrument accepts additional input. While the commands in the full input buffer are being processed, the instrument holds off additional data (by asserting NRFD) until space is available in the input buffer.

When space is available, the instrument can accept the next message before the first has been completely processed.

As described above, after the SG 5050 executes a query output command in a message, it holds the response in its output buffer until the controller makes the instrument a talker. If the instrument receives a new message before all of the output from the previous message is read, it clears the output buffer before executing the new message. This prevents the controller from getting unwanted data from old messages.

One other situation can cause the SG 5050 to delete output. The execution of a long message might cause both the input and output buffers to become full. When this occurs, the instrument cannot finish execution of the message because it is waiting for the controller to read the data it has generated; but the controller cannot read the data because it is waiting to finish sending its message. Because the instrument's input buffer is full and it is holding off the rest of the controller's message with NRFD, the system hangs up with the controller and instrument waiting for each other. When the SG 5050 detects this condition, it generates an error, asserts SRQ and deletes the data in the output buffer.

Instrument Responses to IEEE-488 Interface Messages

The IEEE-488.1-1987 bus standard defines a set of interface commands and the effects of those commands on the instrument's interface functions. This section describes the effects of the IEEE-488 interface messages on SG 5050 operation. The standard abbreviations for these commands are used here.

UNL (Unlisten) and UNT (Untalk)

The UNL command causes the SG 5050 listener function to go to its idle state (unaddressed). In the idle state, the instrument does not accept instrument commands from the IEEE-488 bus.

The UNT command causes the instrument talker function to go to its idle state. In this state, the instrument cannot supply output data via the bus.

The ADRS indicator is off when both the talker and listener functions are idle. If the SG 5050 is either talk-addressed or listen-addressed, the indicator is on.

IFC (Interface Clear)

The IFC command has the same effect as issuing both the UNT and UNL commands. The front panel ADRS indicator is off.

DCL (Device Clear)

The DCL command reinitializes communication between the SG 5050 and its controller. In response to DCL, the instrument clears any input and output messages. Also cleared are any errors or events waiting to be reported, except the power-on event. If the SRQ line is asserted for any reason other than power-on when DCL is received, SRQ is unasserted.

SDC (Selected Device Clear)

The SDC command has the same function as DCL, however, only instruments specifically addressed respond to SDC.

SPE (Serial Poll Enable)

The SPE command enables the SG 5050 to supply output serial poll status bytes when it is talk-addressed.

SPD (Serial Poll Disable)

The SPD command switches the SG 5050 to its normal operation of sending the data from the output buffer.

MLA (My Listen Address) and MTA (My Talk Address)

The SG 5050 IEEE-488 bus address establishes the primary listen and talk addresses. The present setting of the bus address is displayed on the instrument's front panel display when the INST ID button is pressed. When the instrument is addressed to either talk or listen, the front panel ADRS indicator is lighted.

LLO (Local Lockout)

The LLO command causes the SG 5050 to change to a lockout state: from LOCS to LWLS or from REMS to RWLS. The LLO command sent by itself does not set the instrument into Local Lockout. You must send a following command to cause the GPIB circuitry to recognize and assert LLO.

REN (Remote Enable)

If REN is true, the SG 5050 changes to a remote state (from LOCS to REMS if the internal message return-to-local (rtl) is false, or from LWLS to RWLS when its listen address is received). REN false causes a transition from any state to LOCS; the instrument stays in LOCS as long as REN is false.

A REN transition might occur after message processing has started. In this case, execution of the message being processed is not affected by a transition.

GTL (Go To Local)

If the instrument is listen-addressed, the GTL command causes the SG 5050 to change to local state. Remote-to-local transitions caused by GTL do not affect the execution of the message being processed when GTL is received.

Remote-Local Operation

The preceding discussion of interface messages describes the state transitions that the GTL and REN commands cause. Most front panel controls cause a transition from REMS to LOCS by asserting a message called return-to-local (rtl). This transition might occur during message execution; but, in contrast to GTL and REN transitions, a transition initiated by rtl affects message execution. In this case, the instrument generates an error if there are any unexecuted setting or operational commands. Front panel controls that change only the display (such as INST ID) do not affect the remote-local states; only front panel controls that change settings assert rtl. The rtl message remains asserted while multiple keystroke settings are entered, and it is unasserted after the execution of the settings.

The SG 5050 maintains a record of its settings in the present settings buffer and new settings from the front panel or the controller update these recorded settings. In addition, the front panel is updated to reflect setting changes caused by commands. Instrument settings are unaffected by transitions among the four remote-local states. The REM indicator is lighted when the instrument is in REMS or RWLS.

Local State (LOCS)

In LOCS, the operator controls the SG 5050 settings via the front panel pushbuttons and knob. The only bus commands that are executed are those that do not change instrument settings (query-output commands). All other bus commands (setting and operational commands) generate an error since those functions are under front panel control.

Local Without Lockout State (LWLS)

When the SG 5050 is in LWLS, it operates the same as it does in LOCS, except that rtl does not inhibit a transition to remote.

Remote State (REMS)

In REMS, the SG 5050 executes all instrument commands from the GPIB bus. For commands having associated front panel indicators, the front panel is updated when the commands are executed.

Remote With Lockout State (RWLS)

In RWLS, the SG 5050 operates similar to REMS operation except that the rtl message is ignored. (The front panel is locked out.)

Status and Error Reporting

The SG 5050 can alert the controller that it requires service through the service request function (defined in the IEEE-488 Standard). The service request function also provides a means of indicating that an event (a change in status or an error) has occurred. To service a request, the controller performs a serial poll. In response to this poll, the SG 5050 returns a status byte (STB), which indicates whether or not it was requesting service. The STB can also provide a limited amount of information about the request. The format of the information encoded in the STB is given in Figure 3-3. Note that, when data bit 8 is set, the STB conveys device status information, which is contained in bits 1 through 4. (The SG 5050 does not utilize this feature.)

In case of an intermittent error condition, multiple SRQs may be stored in the SG 5050 internal stack. These SRQs can all be simultaneously cleared with a DCL (device clear) command.

NOTE

The SG 5050 status is available over the bus by serial and/or error query, with or without RQS on.

Because the STB conveys limited information about an event, the events are divided into classes, which the STB reports. The classes of events are defined as follows:

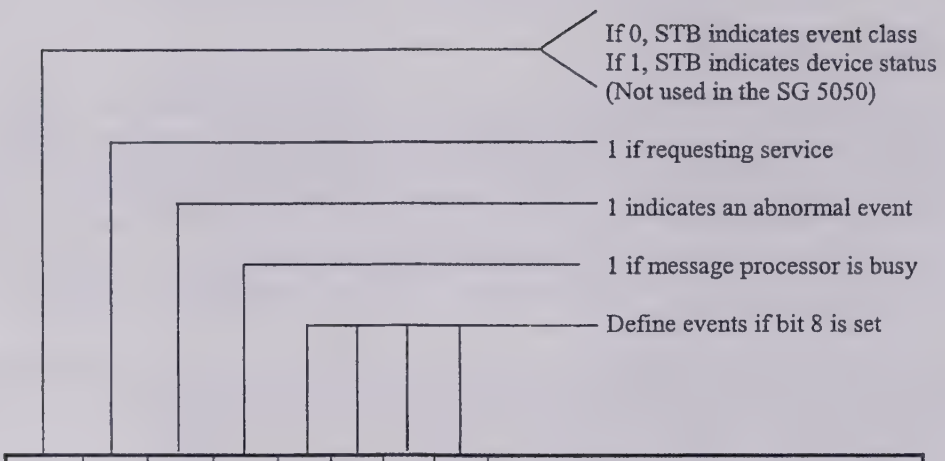
- Command Error - Indicates that the SG 5050 has received a command that it cannot understand. The command does not affect the present state of the instrument.
- Execution Error - Indicates that the instrument has received a command that it understands, but cannot execute because of the present state of the instrument, or because the command is out of the instrument's range.
- Internal Error - Indicates that the instrument has detected a hardware condition or firmware problem that prevents operation.

Error Messages Sent to the Front Panel

Error messages sent to the front panel remain displayed until any front panel button is pushed or a GPIB command is executed.

An NVRAM battery test (E363) error means the battery backed up memory failed, resulting in the front panel setups and the GPIB address and message terminator information being lost. Front panel setups will default to the factory default settings with the GPIB address 10 and message terminator of EOI only.

An EEPROM error, CAL constants lost failure (E364) means the calibration constants are in some way not correct. The instrument then defaults to an output off mode and the front panel RECAL LED will be illuminated.


If 0, STB indicates event class
If 1, STB indicates device status
(Not used in the SG 5050)
1 if requesting service
1 indicates an abnormal event
1 if message processor is busy
Define events if bit 8 is set

8	7	6	5	4	3	2	1	**Bit Position**
128	64	32	16	8	4	2	1	**Decimal Weight**
								Normal Events:
0	1	0	X	0	0	0	1	Power-up (65)
0	1	0	X	0	0	1	1	ID user request (67)
								Abnormal Events:
0	1	1	X	0	0	0	1	Invalid command header (97)
0	1	1	X	0	0	1	0	Settings error (98)
0	1	1	X	0	0	1	1	System error (99)

Figure 3-3: STB Bit Configuration

Bus Error/Event Codes and Serial Poll Response

The SG 5050 provides additional information about many of the events, particularly the errors reported in the STB. The controller can request the additional information by issuing an ERROR? or EVENT? command. In response, the SG 5050 returns a code that defines the event. These codes are described in Table 3-4.

Power-on Sequences and Settings

Each time power is applied to the SG 5050, the internal microprocessor performs a self-test diagnostic routine to check the instrument RAM and ROM functionality. If no RAM or ROM error is found, the microprocessor performs further routines that check the functionality of other instrument hardware.

If a functional failure is detected, an error code is displayed. The error remains displayed until cleared by pressing any front panel button or executing any GPIB command. The SG 5050 responds to input and attempts to function in spite of the error. Refer to Table 3-4 for bus error codes and front panel error codes.

Upon successful completion of the self-tests, the SG 5050 restores the instrument settings that were in use when the instrument was last turned off, except that the sine wave signal to the output head is turned off.

Table 3-4: Error Query and Status Responses

Description	Error/Event Query Response	Serial Poll (Decimal) (Note1)
Command Errors/Events		
System normal	0	NSB (Note 2)
Command header error	101	97 or 113
Header delimiter error	102	97 or 113
Command argument error	103	97 or 113
Argument delimiter error	104	97 or 113
Non-numeric argument	105	97 or 113
Missing argument	106	97 or 113
Invalid message unit delimiter	107	97 or 113
Bad symbol	150	97 or 113
Syntax error	151	97 or 113
Symbol number too long	153	97 or 113
Invalid input character	154	97 or 113
Invalid string input	155	97 or 113
Numerical underflow	156	97 or 113
Execution Errors/Events		
Argument out of range	205	98 or 114
Not in adjustment mode	250	98 or 114
I/O buffers full, output flushed	251	98 or 114
Settings buffer empty	252	98 or 114
Illegal settings number specified	253	98 or 114
Beyond adjustment limit	254	98 or 114
Internal Errors/Events		
Interrupt fault	301	99 or 115
System error	302	99 or 115
HF unleveled	350	99 or 115
Reference loop unlocked	351	99 or 115
Wide loop unlocked	352	99 or 115
Narrow loop unlocked	353	99 or 115
Offset loop unlocked	354	99 or 115
DDS loop unlocked	355	99 or 115
Unplugged error	356	99 or 115
CPU Self-Test Errors		
EPROM checksum failure	360	99 or 115
NVRAM test failure	361	99 or 115
RAM test failure	362	99 or 115
NVRAM battery test failure	363	99 or 115
CAL constant checksum failure	364	99 or 115
Hardware Self-Test Errors		
Output OFF test failure	370	99 or 115
REF freq test failure	371	99 or 115
DDS OFF test failure	372	99 or 115
10.00000 MHz test failure	373	99 or 115
10.00001 MHz test failure	374	99 or 115
500.00000 MHz test failure	375	99 or 115
Wide loop divider test failure	376	99 or 115
Output amp powered test failure	377	99 or 115

System Errors/Event		
No errors or events	0	NSB
Power on	401	65 or 81
ID, user request	403	67 or 83
SRQ pending	455	NSB

Notes:

1. If the message processor is busy, the instrument returns a number 16 (decimal) higher than the serial poll response.
2. No Status Byte.

Programming Example

Talker/Listener Utility Program

The following sample program lets you send any of the commands listed in the Functional Command List and receive the data generated.

Talker/Listener Utility Program for IBM PC Compatibles

```
' ********************************************************************
' ****************** SG 5050 TALKER/LISTENER PROGRAM ****************
' ********************************************************************
' THIS PROGRAM REQUIRES THAT THE SG 5050 ADDRESS BE SET TO THE
' FACTORY DEFAULT OF 10.
COMMON SHARED IBSTA%, IBERR%, IBCNT%
ID$ = "DEV1"
CALL IBFIND (ID$, BD%)          ' SELECT TEKDEVI FOR GPIB ACCESS
SG% = 10                        ' SG% = FACTORY DEFAULT ADDRESS OF 10
CALL IBPAD (BD%, SG%)           ' CHANGE TEKDEV1 PRIMARY ADDRESS TO
ID$ = "GPIB0"                   ' SET UP GPIB FOR BOARD LEVEL
CALL IBSRE (GP%, REMOTE%)       ' COMMUNICATION
REMOTE% = 1
CALL IBSRE (GP%, REMOTE%)       ' SET REMOTE ENABLE
CLS                             ' CLEAR SCREEN
REPLY$ = SPACES$(125)           ' DIMENSION RD$ TO 125
PRINT
"********************************************************************"
PRINT
"************** SG 5050 TALKER/LISTENERPROGRAM **********************"
PRINT
"********************************************************************"
MAINPROG:
PRINT "RETURN TO EXIT; "
INPUT "ENTER MESSAGE(S)"L WRT$
IF WRT$ = " " THEN GOSUB TERMINATE
CALL IBWRT (BD%, WRT$)          ' SEND MESSAGE TO SG 5050
GOSUB CHECKGPIB                 ' CHECK FOR GPIB ERROR GOSUB
CHECKSG                         ' GET SG 5050 ERROR MESSAGE
PRINT : PRINT "INSTRUMENT REPLY ", REPLY$
PRINT : PRINT "Returned status byte: "; SPR%,
PRINT : PRINT ERRM$
GOTO MAINPROG
  ************************* ERROR ROUTINE ****************************
CHECKSG:
ERRM$ = SPACE$(50)
CALL IBRSP (BD%, SPR%)
CALL IBWRT (BD%, "ERR?")
CALL IBRD (BD%, ERRM$)
RETURN
CHECKGPIB:
IF IBSTA% >=0 AND BD% >=0 AND IBSTA% < &H4000 AND IBERR% <> 6 THEN RETURN
' no error to report
IF BD% < 0 THEN PRINT "device not installed - use IBCONF then reboot"
IF IBSTA% > 0 AND IBSTA% >= &H4000 THEN PRINT "timeout"
IF BERR% = 6 THEN PRINT "timeout"
PRINTE "gpib error ", IBERR%
IF IBERR% =  0 THEN PRINT "DOS error device not installed"
IF IBERR% =  1 THEN PRINT "function requires GPIB-PC to be CIC"
IF IBERR% =  2 THEN PRINT "no listener on write function"
IF IBERR% =  3 THEN PRINT "GPIB-PC not addressed correctly"
IF IBERR% =  4 THEN PRINT "invalid argument to function call"
IF IBERR% =  5 THEN PRINT "GPIB-PC not system controller as required"
IF IBERR% =  6 THEN PRINT "I/O operation aborted"
```

```
IF IBERR% =  7 THEN PRINT "non-existent GPIB-PC board"
IF IBERR% = 10 THEN PRINT "I/O started before previous operation completed"
IF IBERR% = 11 THEN PRINT "no capability for operation"
IF IBERR% = 12 THEN PRINT "file system error"
IF IBERR% = 14 THEN PRINT "command error during device call"
IF IBERR% = 15 THEN PRINT "serial poll status byte lost"
IF IBERR% = 16 THEN PRINT "SRQ stuck in ON position"
INPUT "[ENTER] TO CONTINUE"; A$     ' if help$ then
RETURN
' ************************ TERMINATE PROGRAM *********************
TERMINATE:
REMOTE% = 0
CALL IBSRE (GP%, REMOTE%)       ' CLEAR REMOTE ENABLE
PRINT "PROGRAM TERMINATED."
END
```

Section 4
Theory of Operation

Introduction

This section of the manual describes the circuitry in the SG 5050 Programmable Leveled Sine Wave Generator. The description is a discussion of the instrument, using the block diagrams located at the end of this section.

The logic convention (L) is used throughout this section to denote an active Low signal.

SG 5050 Overview

The SG 5050 generates a high spectral purity sine wave whose amplitude is constant over a broad frequency range. In addition, both frequency and amplitude are programmable over the GPIB. The frequency range is 10 kHz to 2500.00000 MHz. The frequency resolution is:

- 1 Hz between 10.000 kHz and 49.999 kHz.
- 10 Hz between 50.00 kHz and 549.99999 MHz.
- 100 Hz between 550.0000 MHz and 1499.9999 MHz.
- 1 kHz between 1500.000 MHz and 2500.000 MHz.

The output amplitude range is 4.5 mV to 5.5 V pk-to-pk (-42.95 dBm to 18.75 dBm, resolution 0.05 dBm). The amplitude resolution is:

- 0.02 mV between 4.50 mV and 55.00 mV.
- 0.2 mV between 55.2 mV and 550.0 mV.
- 2 mV between 552 mV and 5.500 V.

Frequency Control Operation

Two separate signal paths are used to generate the output sine wave, depending on the frequency selected. The Low Frequency (LF) signal covers the range of 10 kHz to 25.000 MHz. This signal is generated by the DDS (direct-digital synthesizer) and directly drives the LF Preamp and Output Amplifier. The High Frequency (HF) signal covers the range of 25.000 MHz through 2500.000 MHz. The HF signal is generated by a PLL (Phase Locked Loop), switchable VCOs and the DDS that is used to generate the PLL reference frequency. The PLL is programmed in large frequency steps and the DDS is programmed in fine steps to generate the specified frequency resolutions. The frequency accuracy of the SG 5050 is determined by the 10 MHz Timebase Oscillator that directly or indirectly feeds all the frequency generator circuitry. This 10 MHz Timebase Oscillator is voltage controllable and can be phase-locked to a precision external 10 MHz reference for even greater frequency accuracy.

Amplitude Control Operation

Coarse control of the output amplitude is provided by the two 20 dB attenuators and the switchable amplifiers on the RF Amplifier Board. Two separate paths provide for control of the

amplitude; one for 10 kHz to 25.00000 MHz (LF), and one for 25.00001 MHz and 2500.000 MHz (HF).

The LF amplitude is controlled through a variable gain amplifier (located on the DDS Board) and processor controlled D/A used to set output amplitude. The detection of output amplitude is performed by a precision rectifier on the RF Deck assembly. The control microprocessor reads the output level and adjusts the amplifier gain accordingly.

The HF amplitude is controlled by a voltage variable 0-40 dB attenuator (VVA). The leveling head generates a DC signal that is proportional to (PEAK-PEAK) output. This signal is read by the microprocessor and is used to control the VVA.

Front Panel and GPIB Operation

The SG 5050 receives commands to change its operation from either the front panel controls or from the GPIB. Once the instrument firmware accepts the command, the instrument is configured to the new setup. All front panel displays and controls communicate with the instrument through the CPU.

Internal Communications

The main processor (MC68306) and the microprocessor (68HC11) communicate over an opto-isolated asynchronous communications link through the Connection Board. The 68HC11 communicates to the VCO and the RF Amp and Deck through a synchronous Serial Peripheral Interface (SPI) bus.

Hardware Diagnostics

The SG 5050 performs several diagnostic checks upon power-up. If errors are detected, error messages are displayed. See Table (3-4) in the Programming section for a complete list of error codes.

During normal operation, the various frequency and amplitude control loops report an error to the CPU through the Interconnect Board if a problem is detected. These errors will indicate that a frequency control loop is not in lock or that the HF amplitude leveling circuit cannot maintain amplitude control. These errors are displayed until cleared by pressing a front panel key.

Block Diagram Description

Eight circuit boards plus the amplitude leveling head comprise the SG 5050. The primary task of each circuit board is as follows:

CPU Board (A3A1)

The CPU issues data and commands to the other circuit boards over the serial bus by way of the Connection Board and to the front panel display over the front panel interface ribbon cable.

GPIB Board (A3A2)

The GPIB board, which is mounted to the CPU board, contains GPIB interface circuitry.

DDS Board (A4A1)

The DDS Board contains the circuitry to control the fine resolution frequency for the HF mode and to directly generate and control the amplitude of the LF mode frequencies. This board also contains the 68HC11 processor that handles the detailed control of all hardware necessary to generate and output the precision sine wave signals.

VCO Board (A4A2)

The VCO Board contains the circuitry to generate the HF sine waves. This consists of a PLL and multiple VCOs that are switched in and out to generate specific frequency ranges.

Output Deck Board (A5A1)

The Output Deck Board contains the control and power supply circuitry necessary to support the Output Amp and Filter Board and to control and power the Leveling Head. It contains multiple power supplies to generate the programmable voltages used to control the Output Amp and Filter Board. It also contains the A/D converter used to detect the leveling head feedback signal and the precision rectifier used to detect LF mode amplitude.

Output Amp and Filter Board (A5A2)

The Output Amp and Filter Board contains the circuitry to filter and amplify/attenuate the output signal to the proper level and purity. It consists of a multiband voltage controlled low-pass filter and a programmable set of amplifiers and attenuators to determine signal sources and flow to generate the proper LF and HF mode outputs.

Leveling Head (A6)

The Leveling Head provides circuitry to detect the amplitude of the LF and HF amplitude. It also contains the precision 50Ω load. The leveling head is not field serviceable.

Connection Board (A2)

The Connection Board is used to distribute power from the various power supplies located on the DDS Board and the Output Deck Board. This board also distributes the control lines used by the processor to configure the circuits as required for the various settings and functions.

Front Panel Board (A1)

The Front Panel Board contains the readout display used to indicate the present amplitude or frequency settings. This board also contains the control knob and pushbutton switches used to set the frequency, set the amplitude, initiate the adjustment procedure, store or recall front panel setups, initialize all twenty front panel setups, or set the GPIB address and message terminator.

Circuit Theory Notes

Frequency Synthesis

The SG 5050 develops its output frequency from a single 10 MHz reference source using phase-locked loop techniques. A typical frequency synthesis loop is shown in Figure 4-1. The highly stable frequency reference, F_{REF}, is one input to the phase/frequency detector. The phase/frequency detector outputs an error correction voltage that drives the loop phase lock. Then, under lock conditions, the phase detector outputs narrow correction voltage pulses that are integrated by the Low Pass Filter generating a control voltage, V_C, which forces the voltage voltage-controlled oscillator (VCO) output frequency and phase to match that of the input reference.

If there is a divider in the loop feedback path of divide ratio N, the output frequency of the VCO is multiplied up in frequency by a factor of N. If the reference frequency is varied in small increments, the output frequency is varied by an amount equal to $F_{REF\ VAR}$ x N. Since the DDS that generates the $F_{REF\ VAR}$ is programmable in .025 Hz steps, the output can be varied in extremely fine increments to generate any specified frequency in the LF and HF mode. Even when N is large, the Output (for example, 250 for 2500 MHz), the output could still be resolved down to 250 x .025 or 7.25 Hz.

Signal Power Notation

At high frequencies it is easier to measure power than voltage. Schematics often show the signal level in terms of dBm. This notation refers to a power ratio compared to 1 milliwatt:

$$10 \log \left(\frac{P}{1mW} \right)$$

As an example, 0 dBm represents 1 mW, 10 dBm represents 10 mW, and 20 dBm represents 100 mW. It is possible to convert the dBm values into voltage into a specified load. In the typical case, the SG 5050 load resistance can be assumed to be 50Ω. The equations that can be used to convert power in dBm to volts are shown below:

$$\text{XdBm} = 10 \log \left(\frac{P}{1mW} \right)$$

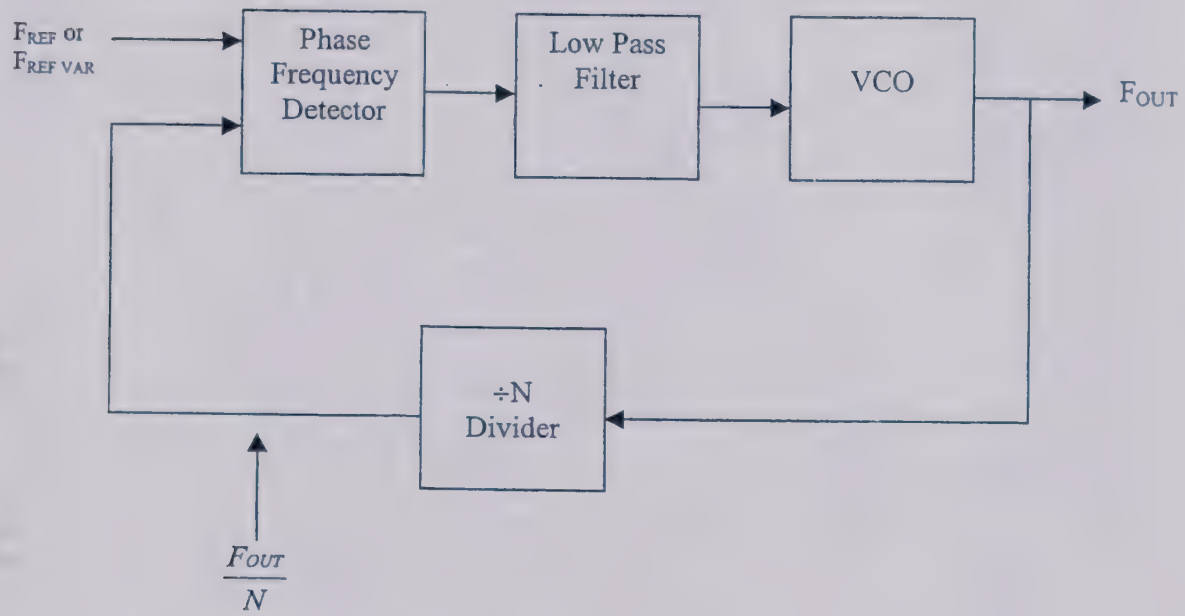
$$P = \frac{Vrms^2}{R_o} = \frac{Vrms^2}{50} \quad \text{for } R_o = 50\Omega$$

$$Vpp = 2\sqrt{2}\ \text{Vrms}$$

$$Vpp = 20 \text{ X } 10^{\left(\frac{\frac{XdBm}{10} - 3}{2} \right)}$$

ECL Signal Levels

Several of the frequency control circuits in the SG 5050 ECL integrated circuits are operated from a +5V supply rather than a more conventional –5.2V supply. This shifts the normal ECL logic levels. Using a +5V supply results in an ECL logic HI of about +4.1V and an ECL logic LO of about +3.3V. The threshold voltage, VB, under these conditions is about +3.7V. A threshold voltage supply is generated locally at several of the ECL ICs where the input signals are AC-coupled in order to minimize noise and reduce the effect of DC voltage offsets between circuit boards.



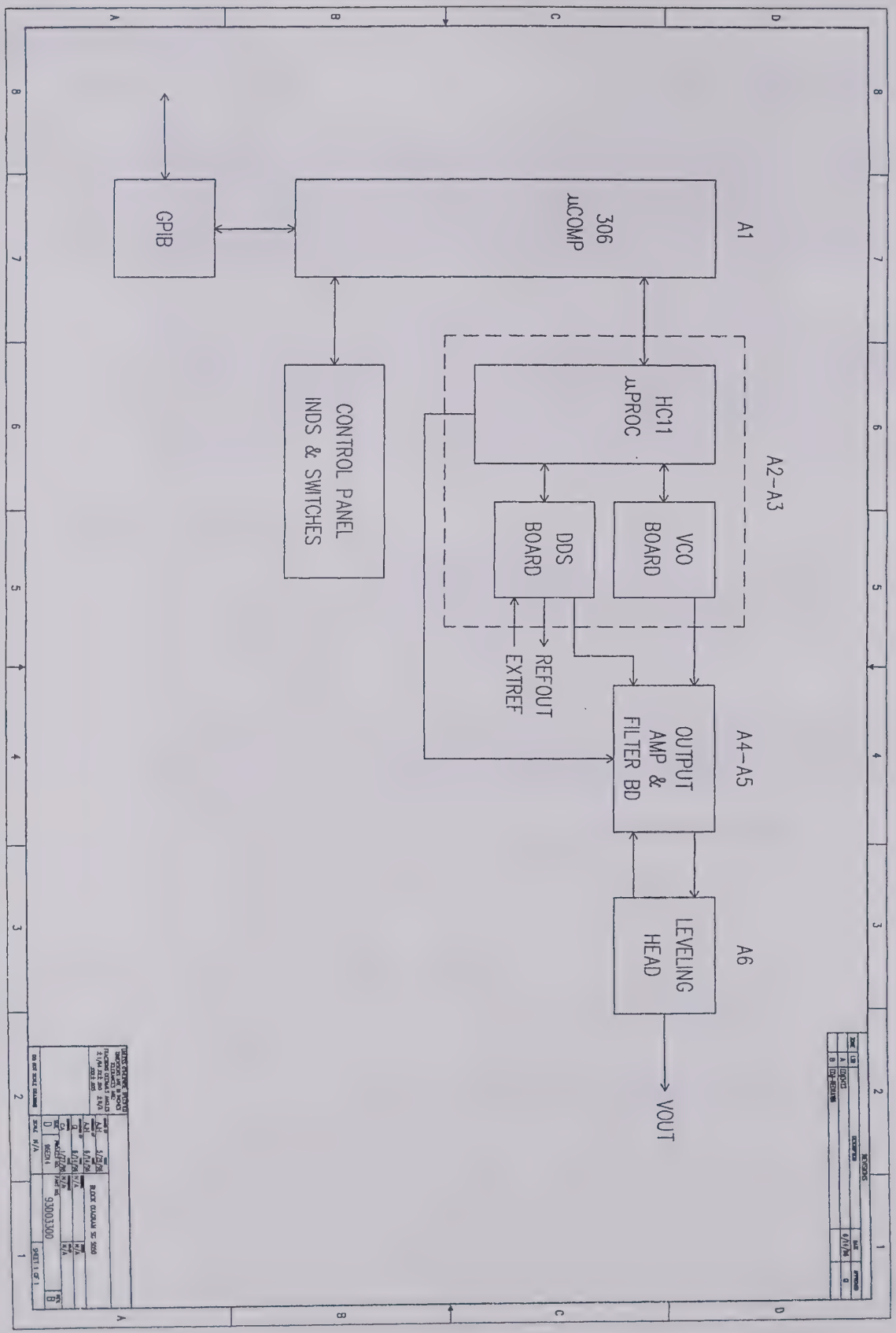
THE LOOP FEEDBACK FORCES

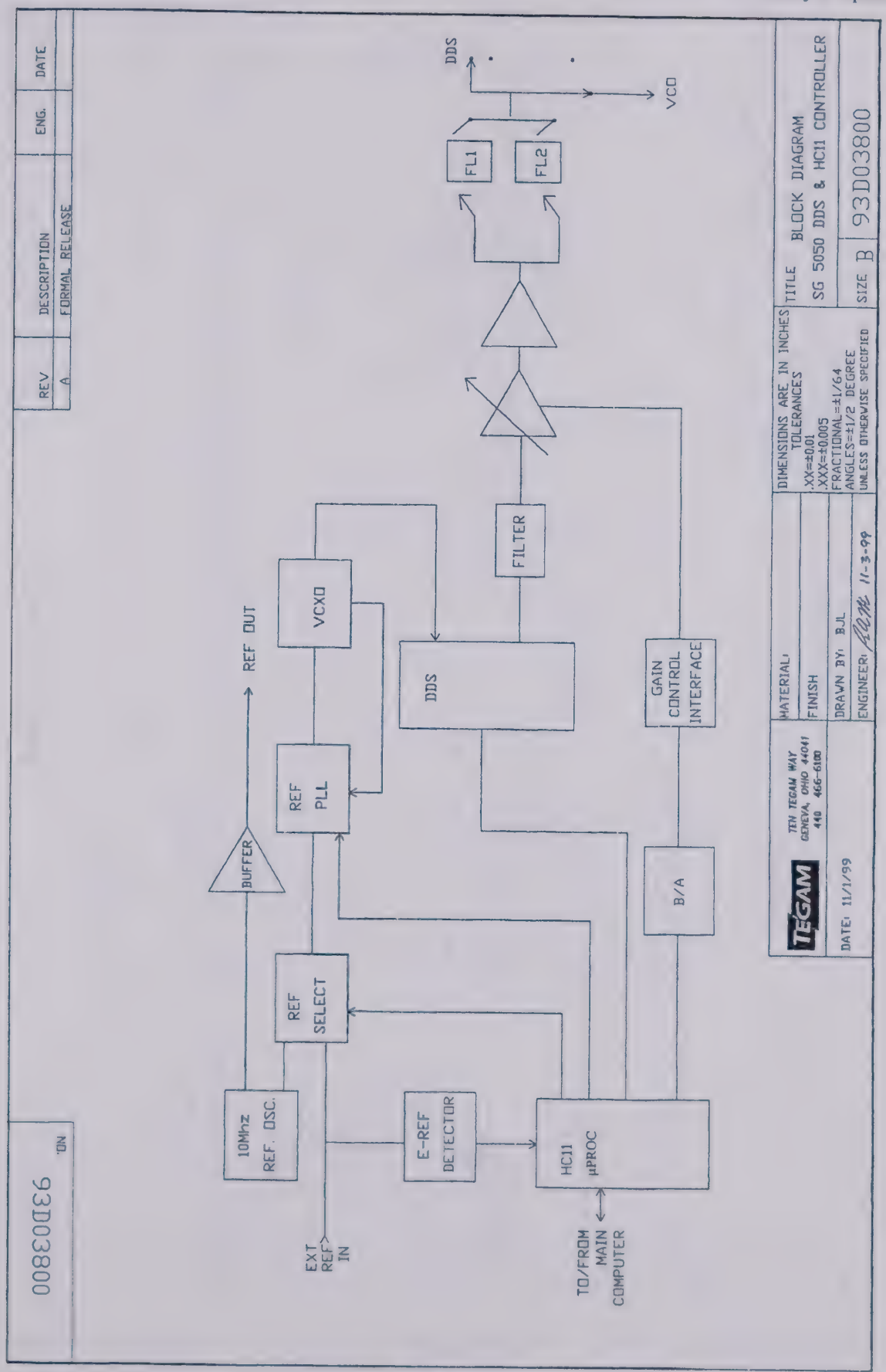
$$F_{REF} = \frac{F_{OUT}}{N}$$

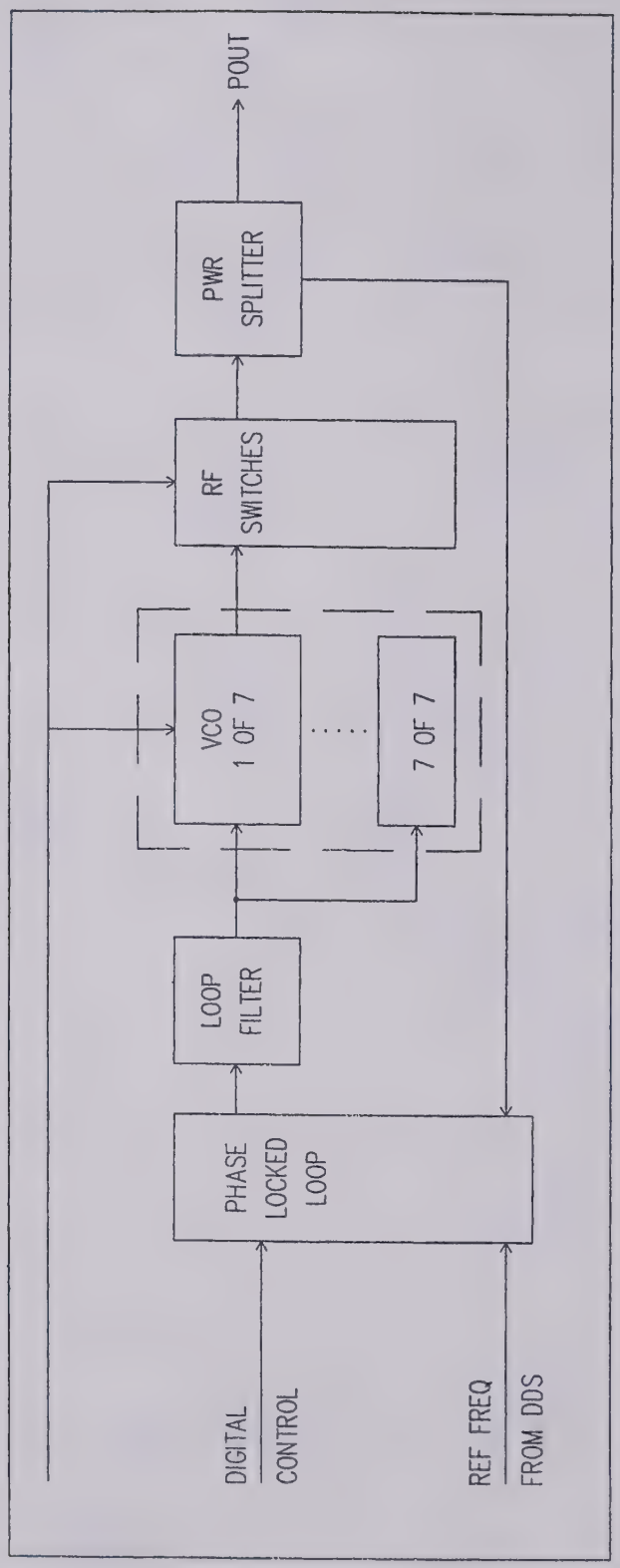
OR

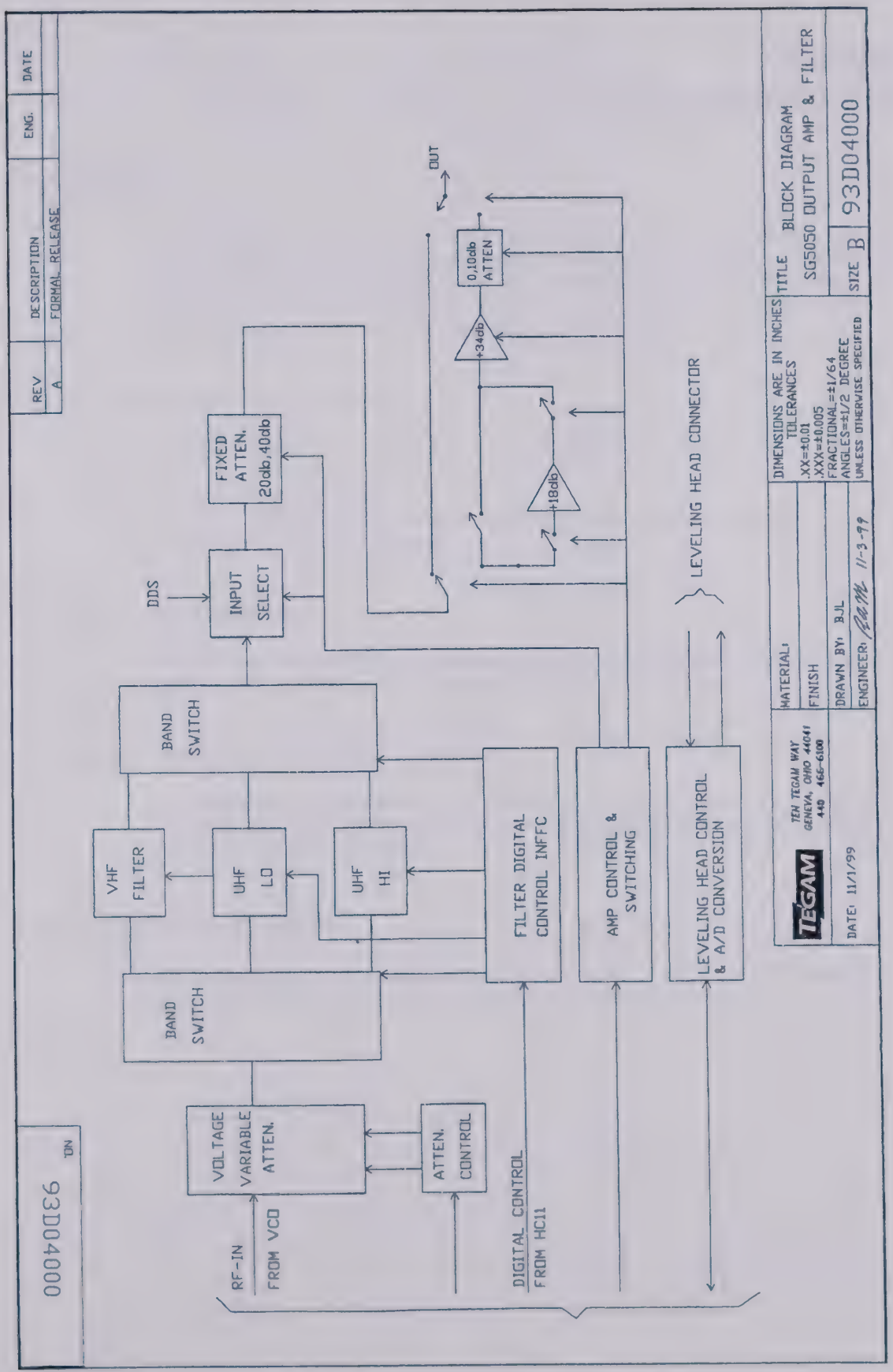
$$F_{REFVAR} = \frac{F_{OUT}}{N}$$

Figure 4-1: Frequency Synthesis Loop


GPIB
306
µCOMP
A1
CONTROL PANEL
INDS & SWITCHES
HC11
µPROC
A2-A3
VCO
BOARD
DDS
BOARD
REFOUT
EXTREF
OUTPUT
AMP &
FILTER BD
A4-A5
LEVELING
HEAD
A6
VOUT


REV
DESCRIPTION
ENG.
DATE
A
FORMAL RELEASE
DDS
VCO
FL1
FL2
FILTER
VCXO
REF OUT
DDS
GAIN CONTROL INTERFACE
REF PLL
BUFFER
B/A
REF SELECT
10Mhz REF. OSC.
E-REF DETECTOR
HC11 µPROC
EXT REF IN
TO/FROM MAIN COMPUTER
93D03800
TEGAM
TEN TEGAM WAY
GENEVA, OHIO 44041
440 466-6100
DATE: 11/1/99
MATERIAL:
FINISH
DRAWN BY: BJL
ENGINEER: 11-3-99
DIMENSIONS ARE IN INCHES
TOLERANCES
.XX=±0.01
.XXX=±0.005
FRACTIONAL=±1/64
ANGLES=±1/2 DEGREE
UNLESS OTHERWISE SPECIFIED
TITLE BLOCK DIAGRAM
SG 5050 DDS & HC11 CONTROLLER
SIZE B
93D03800


POUT
PWR SPLITTER
RF SWITCHES
VCO 1 OF 7
7 OF 7
LOOP FILTER
PHASE LOCKED LOOP
DIGITAL CONTROL
REF FREQ FROM DDS
93D03400


REV
DESCRIPTION
ENG.
DATE
A
FORMAL RELEASE
93D04000
DN
RF-IN
FROM VCO
VOLTAGE VARIABLE ATTEN.
ATTEN. CONTROL
DIGITAL CONTROL
FROM HC11
BAND SWITCH
VHF FILTER
UHF LO
UHF HI
BAND SWITCH
FILTER DIGITAL CONTROL INFFC
AMP CONTROL & SWITCHING
LEVELING HEAD CONTROL & A/D CONVERSION
LEVELING HEAD CONNECTOR
DDS
INPUT SELECT
FIXED ATTEN. 20db,40db
+18db
+34db
0,10db ATTEN
OUT
TEGAM
TEN TEGAM WAY
GENEVA, OHIO 44041
440 466-6100
DATE: 11/1/99
MATERIAL:
FINISH
DRAWN BY: BJL
ENGINEER: 11-3-99
DIMENSIONS ARE IN INCHES
TOLERANCES
XX=±0.01
XXX=±0.005
FRACTIONAL=±1/64
ANGLES=±1/2 DEGREE
UNLESS OTHERWISE SPECIFIED
TITLE BLOCK DIAGRAM
SG5050 OUTPUT AMP & FILTER
SIZE B
93D04000

Section 5
Performance Check

Introduction

This procedure checks the electrical performance requirements as listed in the Specifications section of this manual and may be used for incoming inspection to determine acceptability of performance. If the instrument fails to meet the requirements given in this Performance Check section, the Adjustment Procedure section should be performed. The Performance Check procedure can be performed at any ambient temperature between 0°C and +40°C.

Performance Check Interval

The performance check should be performed at the following intervals:

- At incoming inspection.
- After 2000 hours of operation or every twelve months, if used infrequently.
- After repair of accidental abuse.

Services Available

TEGAM, Inc. provides complete instrument repair facilities at the factory service center. Contact your local TEGAM field office or representative for more information.

Conventions Used in this Procedure

All reference to the SG 5050 front panel controls, connectors and indicators will be indicated by all capital letters. All associated equipment front panel controls, connectors and indicators will be indicated by initial capital letters.

Test Equipment Required

The test equipment, or equivalent (except as noted), listed in Table 5-1 is recommended to perform the Performance Check and Adjustment Procedure in this manual.

Table 5-1: Required Test Equipment

Description	Minimum Requirement	Performance Check	Adjustment Procedure	Recommended Equipment
TM 5000 Series Power Module	Compatible with SG 5050.	X	X	TEGAM TM 5006A
Digital Counter	Timebase Accuracy: 1×10^{-7}	X	X	Hewlett Packard 5350B
GPIB Controller	IBM PC and GPIB adapter card.		X	
Digital Voltmeter	0.25% AC accuracy, 1 Hz to 100 kHz, 55 mV to 5.5 V.	X	X	Hewlett Packard 3458A Multimeter
Spectrum Analyzer	Frequency range 10 kHz to 10 GHz, resolution bandwidth 1 kHz to 3 MHz, reference level range -50 dBm to +20 dBm, frequency response flatness to 10 GHz <±3.0 dB.	X	X	Hewlett Packard 8593E Prog. Spectrum Analyzer
Power Meter	Frequency range 50 kHz to 3 GHz, power range -70 dBm to +20 dBm.	X		Hewlett Packard 437B
Power Sensor	Frequency range 50 MHz to 3 GHz, power range -70 dBm to +20 dBm. Calibrated at test frequencies.	X		Hewlett Packard 8482A
Precision 50Ω BNC Feedthrough Termination	50Ω ± 0.1%	X	X	Tektronix 011-0129-00
Adapter	BNC female to dual banana plug.	X	X	
Adapter	SMA female to N female.	X	X	
Adapter	SMA female to BNC male.	X	X	
Coaxial 50Ω cable (two required)	BNC male to BNC male, 36 in.	X	X	Tektronix part 012-0057-01
Precision Cable SMA male to SMA female	50Ω ± 1Ω, 10 ns ± 1 ns	X		Tektronix 015-1006-00

Preparation

1. Insert the SG 5050 into the power module. Connect the test equipment and the power module to a suitable line voltage source.

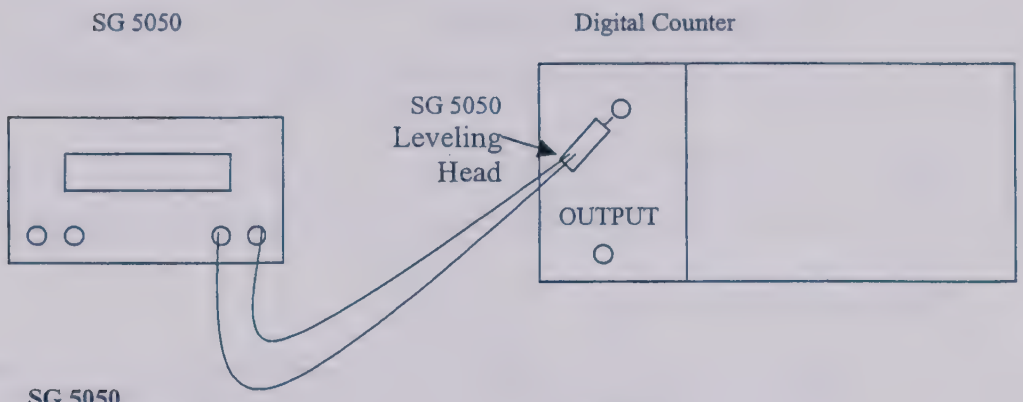
2. Turn on the power module and test equipment, and allow at least 30 minutes warm-up.

Check Frequency Accuracy

This test verifies the output frequency accuracy (10 kHz through 2.5 GHz).

1. Set up the equipment as illustrated in Figure 5-1.

REFER TO TABLE 5-1, REQUIRED TEST EQUIPMENT



SG 5050

AMPL button	Selected
DATA keypad	0 dBm
FREQUENCY VARIABLE button	Selected
DATA keypad	10 KHz
OUTPUT HEAD ON/OFF	ON

Figure 5-1: Frequency Accuracy Check

2. Check that the digital counter readout is between 9.99967 kHz and 10.00033 kHz.
3. Enter 14.999 kHz on the SG 5050 data keypad.
4. Check that the digital counter readout is between 14.99865 kHz and 14.999345 kHz.
5. Enter 15.0000 kHz on data keypad.
6. Check that the digital counter readout is between 14.999655 kHz and 15.000345 kHz.
7. Enter 49.999 kHz on data keypad.
8. Check that the digital counter readout is between 49.99855 kHz and 49.99945 kHz.
9. Select frequency reference button (50 kHz).
10. Check that the digital counter readout is between 49.99685 kHz and 50.00315 kHz.
11. Select frequency variable button.
12. Enter 10 MHz on data keypad.
13. Check that the digital counter readout is between 9.999967 MHz and 10.000033 MHz.
14. Enter 10.00001 MHz on data keypad.

15. Check that the digital counter readout is between 9.999977 MHz and 10.000043 MHz.

16. Enter 550 MHz on the data keypad.

17. Check that the digital counter readout is between 549.998347 MHz and 550.001653 MHz.

18. Enter 1000 MHz on the data keypad.

19. Check digital counter readout is 1000MHz within the limits of 999.997MHz to 1000.003MHz.

20. Enter 2500MHz on the data keypad.

21. Check that the digital counter readout is between 2499.9925 MHz and 2500.0075 MHz.

Check Spectral Purity

This test verifies that the amplitude of the 2nd harmonic is less than –30 dBc, the amplitude of the 3rd is less than –35 dBc, and higher harmonics (only tested through 5th harmonic) are less than -40 dBc of the fundamental frequency. The test is made at the SG 5050's maximum amplitude, which is the condition for worst case harmonics.

The test starts with a spot check below 50 kHz and then sweeps the SG 5050 frequency using the front panel control knob up to the maximum frequency. You should adjust the spectrum analyzer to maintain at least five harmonics on the screen at all times. You will have to continuously adjust start and stop frequencies and band selections to perform measurements.

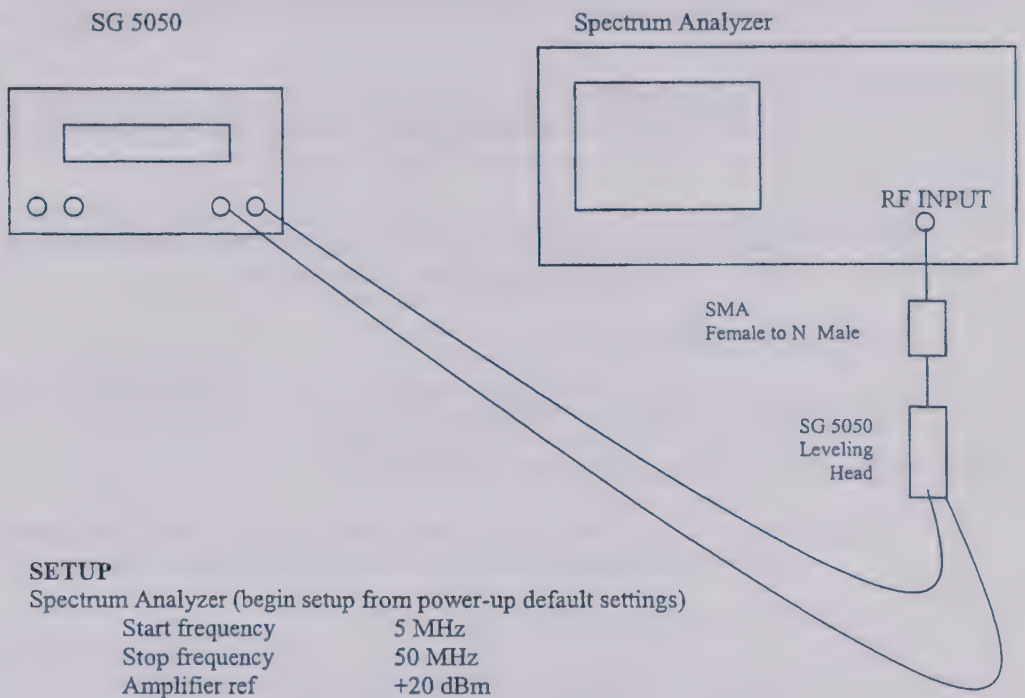
1. Set up the equipment as illustrated in Figure 5-2.

2. Find the first peak. This should set the marker on the peak of the 10 MHz signal.

3. Set the ref level on the spectrum analyzer to +20 dBm ±1 dBm. The ref level should not be changed during the rest of the procedure.

4. Set SG 5050 frequency to 50 kHz. Set the spectrum analyzer start/stop frequencies to 20 kHz and 300 kHz respectively.

REFER TO TABLE 5-1, REQUIRED TEST EQUIPMENT



SETUP

Spectrum Analyzer (begin setup from power-up default settings)

Start frequency	5 MHz
Stop frequency	50 MHz
Amplifier ref	+20 dBm
Marker	on
B.W.	100 kHz

SG 5050

AMPL button	Selected
DATA keypad	5.5 V
FREQUENCY VARIABLE button	Selected
DATA keypad	10 MHz
OUTPUT HEAD ON/OFF	ON

Figure 5-2: Spectral Purity Check

5. Check the 2nd harmonic amplitude peak is at least 3 divisions (-30 dBc) and that the 3rd harmonic amplitude peak is at least 3.5 divisions (-35 dBc) below the top horizontal graticule line (fundamental reference amplitude).

6. Check that 4th and 5th harmonic amplitude peaks are at least 4 divisions (-40 dBc) below the top horizontal graticule line.

7. Use the DIGIT SELECT buttons on the SG 5050 to set the control knob resolution to 10 kHz. Then, using the control knob, slowly increase the SG 5050 frequency to 1 MHz. While doing that, monitor the harmonics using the spectrum analyzer as in steps 5 and 6.

NOTE

In this and all of the following steps, as the SG 5050 frequency is increased, the spectrum analyzer center frequency and span need to be increased to allow the first five harmonics of the SG 5050 output frequency to be observed. Be careful that the spectrum analyzer span is not made too large compared to the frequency being measured or the accuracy of the amplitude measurement may be compromised.

8. Use the DIGIT SELECT buttons to set the control knob resolution to 100 kHz. Then, using the control knob, increase the SG 5050 frequency to 10 MHz. While doing that, monitor the harmonics using the spectrum analyzer as in steps 5 and 6.

9. Use the DIGIT SELECT buttons to set the control knob resolution to 1 MHz. Then, using the control knob, increase the SG 5050 frequency to 25 MHz. While doing that, monitor the harmonics using the spectrum analyzer as in steps 5 and 6.

10. Set control knob resolution to 10 MHz.

11. Use the SG 5050 control knob to increase the frequency to 1100 MHz. While doing that, monitor the harmonics using the spectrum analyzer as in steps 5 and 6.

12. Adjust the amplitude of the SG 5050 to 3.3V.

13. Use the SG 5050 control knob to increase the frequency to 2500 MHz. While doing that, monitor the harmonics using the spectrum analyzer as in steps 5 and 6.

14. Adjust the amplitude of the SG 5050 to 5.5V.

15. Use the SG 5050 control knob to decrease the frequency to 1100 MHz. While doing that, monitor the harmonics using the spectrum analyzer as in steps 5 and 6, except that the limit for 2^{nd} is 2.5 divisions and for 3^{rd} is 3 divisions.

Check Amplitude Accuracy

This test verifies amplitude accuracy from 10 kHz to 50 kHz. Set up the equipment as illustrated in Figure 5-3. The DVM is configured to measure AC RMS volts using synchronous sampling conversion.

Make a copy of Table 5-2. The Output Voltage (RMS) and Absolute Tolerance Limits (RMS) have been derived using the following factor for the output waveform:

$$RMS = \text{pk-pk} \times 0.5 \times 0.707107$$

This factor applies only when the DVM input is AC-coupled through a large capacitance.

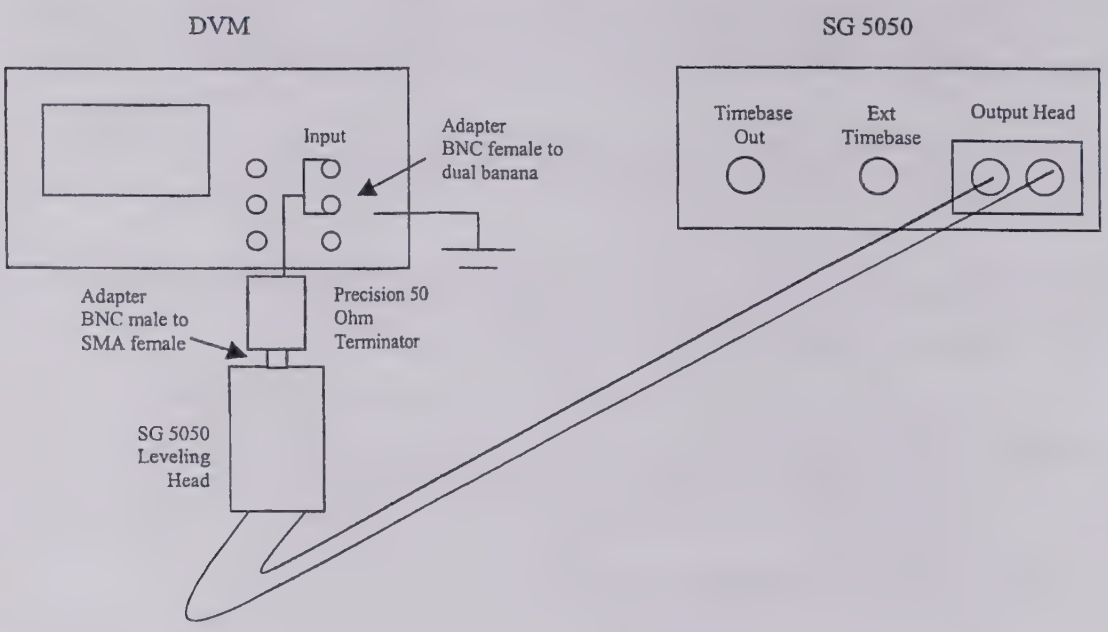
Carry out the following operations at each verification point:

1. On the DVM, select the correct voltage range for the Output Voltage (RMS) at the verification point.
2. On the SG 5050, set the Output Voltage (pk-pk) as required for the verification point.
3. On the SG 5050, set the Output Head ON and wait for the DVM to settle.
4. Measure the Output Voltage (RMS) value and record it in the Measured Value (RMS) column of the table.
5. On the SG 5050, set the Output Head OFF.

Table 5-2: Sine Verification into 50Ω Load

Frequency	Output Voltage (pk - pk)	Absolute Tolerance Limits (pk - pk)		Output Voltage (RMS)	Absolute Tolerance Limits (RMS)		Measured Valve (RMS)
		Lower	Higher		Lower	Higher	
10	5.5 Volts	5.4175	5.5825	1.9445	1.9154	1.9737	
10	564 mV	555,5400	572.4600	199.4042	196.4131	202.3952	
10	562 mV	553.5700	570.4300	198.6971	195.7166	201.6775	
10	64 mV	63.0400	64.9600	22.6274	22.2880	22.9668	
10	63 mV	62.0550	63.9450	22.2739	21.9398	22.6080	
10	4.5 mV	4.4325	4.5675	1.5910	1.5671	1.6149	
20	5.5 Volts	5.4175	5.5825	1.9445	1.9154	1.9737	
20	564 mV	555.5400	572.4600	199.4042	196.4131	202.3952	
20	562 mV	553.5700	570.4300	198.6971	195.7166	201.6775	
20	64 mV	63.0400	64.9600	22.6274	22.2880	22.9668	
20	63 mV	62.0550	63.9450	22.2739	21.9398	22.6080	
20	4.5 mV	4.4325	4.5675	1.5910	1.5671	1.6149	
50	5.5 Volts	5.4175	5.5825	1.9445	1.9154	1.9737	
50	564 mV	555.5400	572.4600	199.4042	196.4131	202.3952	
50	562 mV	553.5700	570.4300	198.6971	195.7166	201.6775	
50	64 mV	63.0400	64.9600	22.6274	22.2880	22.9668	
50	63 mV	62.0550	63.9450	22.2739	21.9398	22.6080	
50	4.5 mV	4.4325	4.5675	1.5910	1.5671	1.6149	

REFER TO TABLE 5-1, REQUIRED TEST EQUIPMENT



SETUP

Digital Voltmeter

Blue button	Press
Reset button	Press
ACV button	Select
Blue button	Press
S	Press
Down arrow	Press until SETACV
Right arrow	Press once
Down arrow	Press until SETACV SYNC
Enter button	Press

SG 5050

FREQUENCY REFERENCE button	Selected
AMPL button	Selected
DATA keypad	As required
OUTPUT HEAD ON/OFF	As required

Figure 5-3: Amplitude Accuracy Check

Check Amplitude Flatness

This test verifies amplitude flatness from 50 kHz to 2.5 GHz. Set up the equipment as illustrated in Figure 5-3. Make a copy of Tables 5-3 through 5-6.

Starting with Table 5-3, carry out the following operations at each verification point:

1. On the SG 5050, set the Output Voltage (pk-pk) as required for the verification point, set the Output Frequency to 50 kHz, and set Output ON.
   On the power meter, select autoranging or a range that gives an on-scale reading.
2. Measure the SG 5050 output voltage at 50 kHz and calculate the pk-pk value of SG 5050 output voltage into 50Ω:

$$\text{Pk-Pk Voltage} = 2.828 * \text{measured RMS value}$$

3. Record the result in the "Measured p-p Voltage at 50 kHz" column of the table.

Repeat the above procedure for Tables 5-4 through 5-6.
Set up the equipment as illustrated in Figure 5-4 and Start with Table 5-3.

4. On the SG 5050, set the Output Frequency to 1 MHz.
5. Measure the SG 5050 output power at 1 MHz and calculate the pk-pk value of SG 5050 output voltage into 50Ω:

$$\text{Pk-Pk Voltage} = 20\sqrt{(\text{power into } 50\Omega)}$$

6. Record the result in the "Measured p-p Voltage for Flatness Check" column of the table.
7. Set the SG 5050 to the next frequency in the table, and repeat step 5.

Repeat the above procedure for Tables 5-4 through 5-6.

8. On the SG 5050, set the Output Head OFF.

Calculation of Validity Tolerances

Flatness is normally expressed as a voltage relative to that at a reference frequency of 50 kHz. Tables 5-3 through 5-6 are used to record the values at the reference frequency.

For the flatness verification, each output voltage is measured as power into 50Ω in an RF power meter, and converting to pk-to-pk voltage using the formula given in the procedure. This voltage is compared to the voltage reading at 50 kHz, by checking that it is within validity tolerance limits about the 50 kHz value.

To calculate the validity tolerance limits at each verification point, the Total Measurement Uncertainty and the specified SG 5050 flatness, with respect to 50Ω, must be taken into account. These are combined using an RSS calculation.

Example: Calculation of Validity Tolerance at 10 MHz

- From the power meter specifications, suppose the Total Measurement Uncertainty (Power) at 10 MHz, including the sensor uncertainty, is ±1.4%.
- Since this is a power uncertainty, the pk-pk voltage uncertainty is half (±0.7%).
- To this, combine (by RSS method) the SG 5050 pk-pk voltage flatness specification. At 10 MHz, the SG 5050 specification relative to 50 kHz is ±1.5%.

$$\text{Validity Tolerance} = \sqrt{[(0.007)^2 + (0.015)^2]}$$
$$= \pm 0.01655 = \pm 1.655\%$$

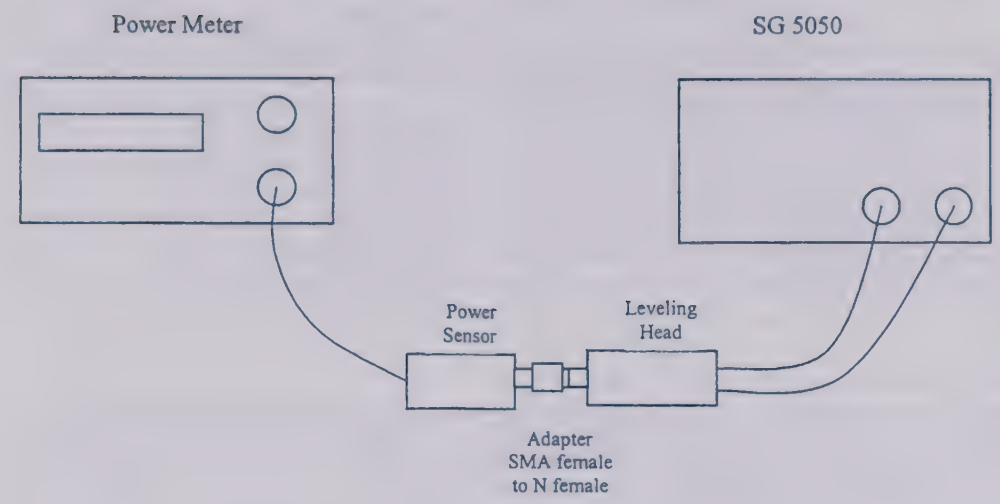
- Multiply this by the Reference Value at 50 kHz, and obtain the higher limit at 10 MHz by adding the Validity Tolerance to the 50 kHz Reference Value. The lower limit at 10 MHz is found by subtracting the Validity Tolerance from the 50 kHz Reference Value.

Uncertainty Calculations and Flatness Check

For each of the verification points in Tables 5-3 through 5-6:

1. Insert the User's Measurement Uncertainty (Um).
2. Combine the Total Measurement Uncertainty and the SG 5050 sine function accuracy, using the RSS method, to calculate the Flatness Validity Tolerance Limits.
3. Enter the limits in the appropriate columns of the tables.
4. Check that the Measured p-p voltage is at or between the Flatness Validity Tolerance Limits.

REFER TO TABLE 5-1, TEST EQUIPMENT REQUIRED



SETUP

Power Meter Set to measure dBm at the frequency of interest

SG 5050

FREQUENCY VARIABLE button	Selected
DATA keypad	As required
AMPL button	Selected
DATA keypad	As required
OUTPUT HEAD ON/OFF	As required

Figure 5-4: Amplitude Flatness Check

Table 5-3: Sine Flatness Verification at 5.5 V into 50 Ω Load

Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
					Lower	Higher	
5.5 V	50 kHz						
	1 MHz		±1.5				
	50 MHz		±1.5				
	100 MHz		±1.5				
	250 MHz		±3.0				
	500 MHz		±4.0				
	1 GHz		±4.0				
	2.5 GHz		±4.0				

Table 5-4: Sine Flatness Verification at 1.1 V into 50 Ω Load

Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
					Lower	Higher	
1.1 V	50 kHz						
	1 MHz		±1.5				
	50 MHz		±1.5				
	100 MHz		±1.5				
	250 MHz		±3.0				
	500 MHz		±4.0				
	1 GHz		±4.0				
	2.5 GHz		±4.0				

Table 5-5: Sine Flatness Verification at 1.0 V into 50 Ω Load

Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
					Lower	Higher	
1.0 V	50 kHz						
	1 MHz		±1.5				
	50 MHz		±1.5				
	100 MHz		±1.5				
	250 MHz		±3.0				
	500 MHz		±4.0				
	1 GHz		±4.0				
	2.5 GHz		±4.0				

Table 5-6: Sine Flatness Verification at 175 mV into 50 Ω Load

Nominal Output Voltage	Output Frequency	Measured p-p Voltage at 50 kHz	Specification Relative to 50 kHz (% of Output)	User's Total Measurement Uncertainty (Um)	Flatness Validity Tolerance Limits		Measured p-p Voltage for Flatness Check
					Lower	Higher	
175 mV	50 kHz						
	1 MHz		±1.5				
	50 MHz		±1.5				
	100 MHz		±1.5				
	250 MHz		±3.0				
	500 MHz		±4.0				
	1 GHz		±4.0				
	2.5 GHz		±4.0				

Check Output VSWR

A worksheet (Table 5-7) is provided at the end of this step to record the various measurement readings required. These measurement readings will be used to calculate the VSWR of your instrument.

Description

This test verifies that the VSWR is 1.2:1 or less up to 550 MHz and less than 1.3:1 up to 2500 MHz.

Procedure

a) Set up the equipment as illustrated in Figure 5-6.
b) Press the dBm/W button then the zero button to reset the display. Verify the display reads zero.
c) Again press the dBm/W button. Now connect the Power Meter Sensor Head to the T - connector as shown in Figure 5-6. Turn the SG 5050 OUTPUT to ON.

d) Use the SG 5050 <DIGIT SELECT> buttons to choose the first zero to the left of the decimal point of the SG 5050 display.
e) Slowly rotate the SG 5050 Control Knob counterclockwise (lowering the frequency) while watching the Power Meter readout display. The displayed readout will eventually reach a first maximum or minimum value (null). NOTE: As you decrease the frequency, the readout value will continuously alternate between maximum and minimum values as the power output level varies. Refer to Figure 5-7 for an illustration describing the points at which measurements are to be taken. The actual frequencies at which VSWR measurements should be taken will vary from instrument to instrument.
f) Record the first Power Meter readout value in Table 5-7, line 1 column 1.
g) Continue to lower the SG 5050 frequency while watching the Power Meter readout value. The readout will reach a second maximum or minimum.
h) Record the second Power Meter readout value in Table 5-7, line 2 column 1.

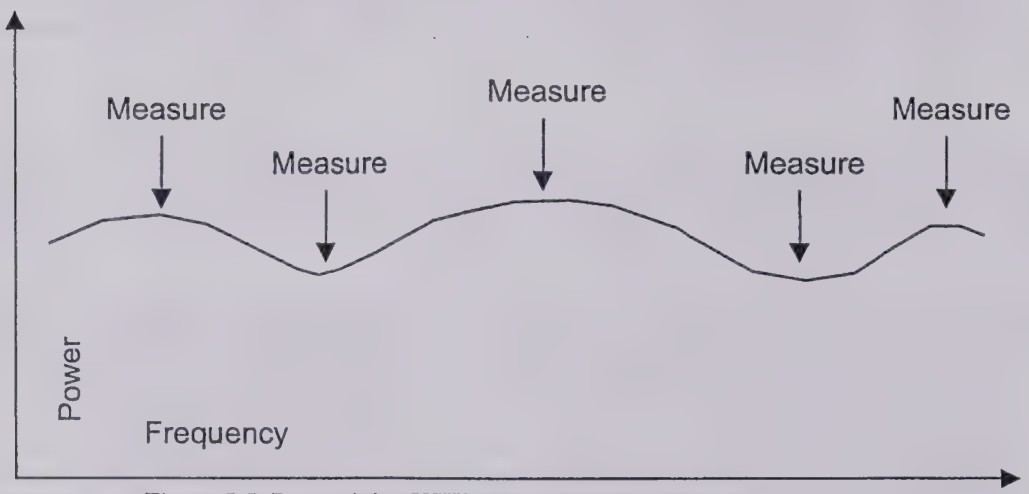
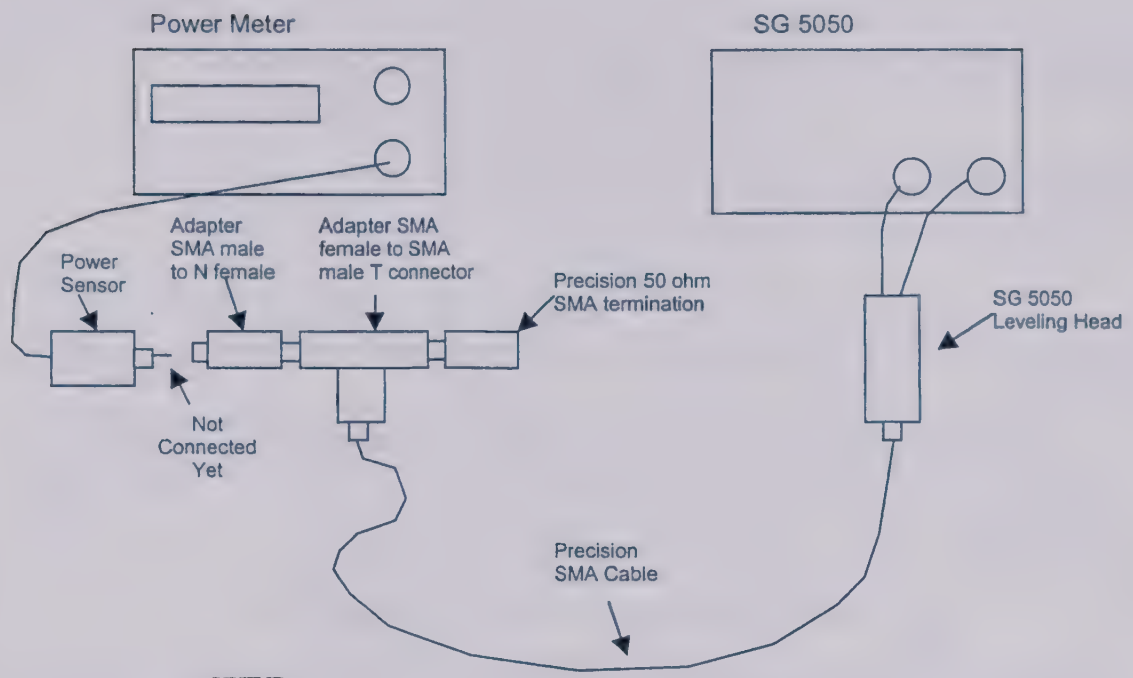


Figure 5-5: Determining VSWR Measurement Points

REFER TO TABLE 5-1, TEST EQUIPMENT REQUIRED



SETUP:

Power Meter

Green Preset Button	Press
Enter Button	Press
Blue Shift Button	Press
dBm/W Resoln Button	Select
Down Arrow Button	Press until display reads RES3 0.001 dB
Enter Button	Press

SG 5050

AMPL Button	Selected
keypad	550 mv
FREQUENCY VARIABLE	Selected
keypad	550 MHz
OUTPUT HEAD ON/OFF	OFF

Figure 5-6: VSWR Check

Table 5-7: VSWR Worksheet

Reading Number	Min/Max Value at 550 mv	
	550 MHz	2500 MHz
1		
2		
Delta		
3		
4		
Delta		

i) Repeat parts (g) and (h), recording the values in Table 5-4 column 1 for a second maximum and minimum.
j) Press the SG 5050 FREQUENCY VARIABLE button. Enter **2500 MHz** on the DATA keypad.

k) Repeat parts (e) through (j) for 2500 MHz, entering the readings in Table 5-7, column 2 .
l) For each max/min measurement pair (i.e. Table 5-7 lines 1 and 2, column 1), calculate the difference (Delta), using the equation:

Delta = (first reading) – (second reading)

Enter the calculated value on the line immediately below the measurement pair, ignoring polarity.

m) CHECK that the magnitude of the difference between each min/max value entered in Table 5-7 is less than 0.52 dBpk-pk for 550 MHz or 0.76 dB for 2500 MHz.

Disconnect all test equipment.

This completes the SG 5050 Performance Check.

Section 6
Adjustment Procedure

Introduction

The calibration procedure for the SG 5050 is performed by the TEGAM software running on the equipment listed in Table 6-1. It automatically controls the instruments and informs you when to change connections or change instrument setup.

All data is recorded internally and used by the instrument controller to develop the calibration data tables that are loaded into the instrument's NVRAM. At the completion of the calibration, an automatic verification program is run that creates before and after data results. This complete procedure will take approximately four hours.

Table 6-1: Required Test Equipment

Description	Minimum Requirement	Perf. Check	Adjustment Procedure	Recommended Equipment
TM 5000 Series power module	Compatible with SG 5050	X	X	TEGAM TM 5006A
Digital Counter	Time base accuracy: 1×10^{-7}	X	X	Hewlett Packard HP5350B
Spectrum Analyzer	Frequency 9 kHz to 26.5 GHz Resolution BW 1 kHz to 3 MHz Reference level range -50 dBm to +20 dBm Response flatness <±3 dBm.	X	X	Hewlett Packard HP8593E
Digital Voltmeter	0.25% AC accuracy 10 kHz to 10 MHz 5.5 mV to 5.5 V	X	X	Hewlett Packard HP3458A
Power Meter	Frequency range 10 MHz to 3 GHz, power range -70 dBm to +20 dBm.	X		Boonton 5230
Power Sensor	Frequency range 10 MHz to 3 GHz, power range –70 dBm to +20 dBm. Calibrated at test frequencies.	X		Boonton 51075
Precision 50Ω BNC Feedthrough Termination	50Ω ± 0.1%	X	X	Tektronix 011-0129-00
Adapter	BNC female to dual banana plug.	X	X	
Adapter	SMA female to N female	X	X	
Adapter	SMA female to BNC male.	X	X	
Coaxial 50Ω cable (two required)	BNC male to BNC male, 36 in.	X	X	Tektronix part 012-0057-01
GPIB Controller	IBM PC or equivalent with GPIB interface	X	X	PC with National Instruments PC2A
Control Software	TEGAM	X	X	No substitution
10 dB Pad	Type 'N' 10 dB dc – 18 GHz	X	X	Weinschel Model 2-10

Preparation

1. Adjustments must be performed in an instrument that has had its top cover removed and in a power module with the top cover removed. Refer to Section 7 for cover removal instructions.

2. Using a screwdriver, remove the oscillator adjustment cover on the DDS Board assembly.

3. Connect the test equipment and power module to a suitable line voltage source, turn on, and allow to warm for a minimum of 30 minutes.

4. During warm-up, connect the SG 5050 leveling head to a suitable 50Ω dummy load, and set for +18 dBm output at 1000 MHz.

Adjust Output Amp Power Supply

With the SG 5050 set as in step 4 above, connect voltmeter +lead to Output Deck Board C71, +Terminal and the -lead to C71, -Terminal. The voltmeter should read 15 V ±0.1 V. Adjust R59 on the Output Deck Board, if necessary. (Refer to component layout 30D24802 in Section 7.)

Adjust Internal Timebase Frequency

1. Connect SG 5050 timebase out to a suitable counter.

2. Prepare as described above.

3. Adjust oscillator on DDS Board with an insulated alignment tool to a readout of 10.000000 MHz ±.000010, if necessary.

4. Replace adjustment cover when finished.

Perform Instrument Amplitude Calibration

The amplitude calibration is performed via a computer and automated measuring equipment. All instruments must be connected via the GPIB bus and the specified software installed. The calibration then involves running and following the software instructions. At the end of this process, the control computer automatically updates the calibration data table that is in the SG 5050 CPU.

NOTE: Calibration software is not available as of this printing. Please refer to the TEGAM web page (www.tegam.com) for updates and to download software. Or, contact customer service at 440-466-6100 (phone), or 440-466-6110 (fax).

You must set up the equipment according to Figure 6-1, and then start the calibration software. You will be instructed for any further actions required by the readout on the computer's CRT.

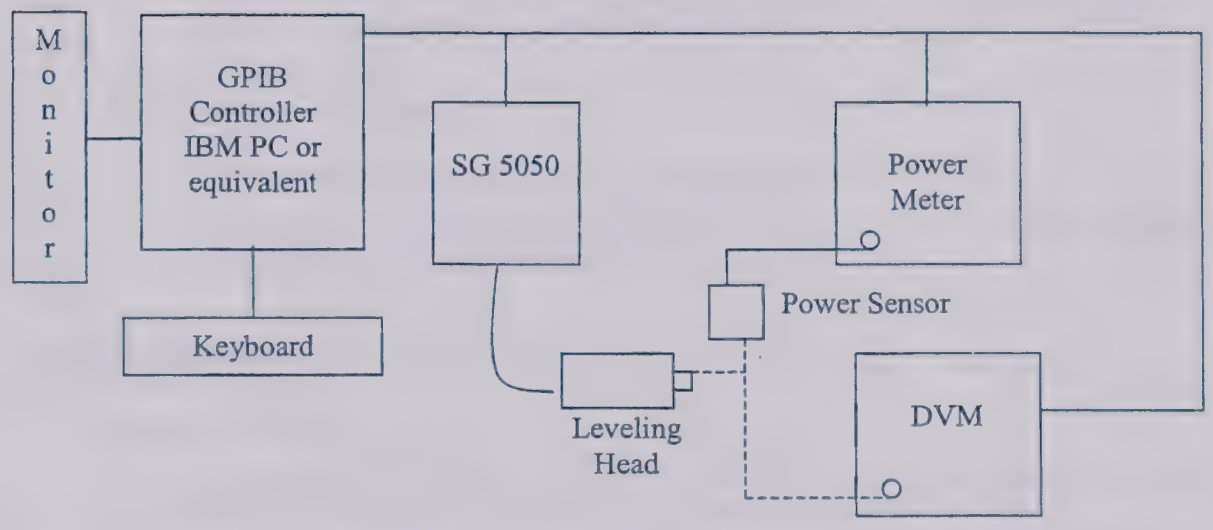


Figure 6-1: Instrument Amplitude Calibration

Section 7
Maintenance

Introduction

This section of the manual gives rear interface information and provides general maintenance and service information for the SG 5050 Sine Wave Generator.

WARNING

The information in this section is intended for qualified service personnel. Some of the procedures may expose you to hazardous voltages that could result in personal injury or death. Do not attempt to perform these procedures unless you are qualified to do so.

CAUTION

To prevent damage to the SG 5050, turn off the power module before installing or removing the instrument. Do not use excessive force to install or remove the SG 5050 from the power module.

Rear Interface Information

The pin assignments shown in Figure 7-1 are identical for the CPU Board and the Output Board.

Figure 7-2 shows the pin assignments for the GPIB connector on the CPU Board. Figure 7-3 shows the pin assignments for the DDS/VCO Board.

General Maintenance

Loss of NVRAM

Stored setups and the present contents of the SG 5050 front panel buffer will be lost upon failure of either one or both of the internal NVRAMs (front panel error codes 363 and 354).

Upon NVRAM failure, either one or both of these NVRAM ICs must be replaced to restore the nonvolatile memory capability. The SG 5050 must be recalibrated and all stored setups must be re-entered upon completion of any NVRAM replacement.

CPU BOARD AND OUTPUT BOARD
PLUG-IN REAR VIEW

FUNCTION	CONTACT	CONTACT	FUNCTION
	13B	13A	
+26 VDC	12B	12A	+26 VDC
COLLECTOR LEAD OF PNP SERIES PASS	11B	11A	BASE LEAD OF PNP SERIES PASS
	10B	10A	EMITTER LEAD OF PNP SERIES PASS
GROUND	9B	9A	GROUND
-26 VDC	8B	8A	-26 VDC
COLLECTOR LEAD OF NPN SERIES PASS	7B	7A	EMITTER LEAD OF NPN SERIES PASS
			TM 5000 BARRIER SLOT
PWR	6B	6A	BASE LEAD OF NPN SERIES PASS
	5B	5A	
GROUND	4B	4A	GROUND
GROUND	3B	3A	GROUND
+8 VDC FILTERED	2B	2A	+8 VDC FILTERED
	1B	1A	

Figure 7-1: CPU and Output Board Rear Interface

REAR INTERFACE GPIB CONNECTOR
PLUG-IN REAR VIEW

FUNCTION	CONTACT	CONTACT	FUNCTION
DIO1	1	2	DIO5
DIO2	3	4	DIO6
DIO3	5	6	DIO7
DIO4	7	8	DIO8
NC	9	10	NC
EOI	11	12	IFC
DAV	13	14	SRQ
NRFD	15	16	ATN
NDAC	17	18	REN
GND	19	20	NC

Figure 7-2: GPIB Rear Interface

DDS/VCO BOARD
PLUG-IN REAR VIEW

FUNCTION	CONTACT	CONTACT	FUNCTION
	28B	28A	
	27B	27A	
	26B	26A	
	25B	25A	
	24B	24A	
SG BARRIER SLOT			
	23B	23A	
	22B	22A	
	21B	21A	
	20B	20A	
	19B	19A	
	18B	18A	
	17B	17A	
	16B	16A	
TIMEBASE OUT (See note)	15B	15A	TIMEBASE OUT RETURN (See note)
EXT TIMEBASE INPUT RETURN (See note)	14B	14A	EXT TIMEBASE INPUT (See note)
	13B	13A	
+26 VDC	12B	12A	+26 VDC
COLLECTOR LEAD OF PNP SERIES PASS	11B	11A	BASE LEAD OF PNP SERIES PASS
	10B	10A	EMITTER LEAD OF PNP SERIES PASS
GROUND	9B	9A	GROUND
-26 VDC	8B	8A	-26 VDC
COLLECTOR LEAD OF NPN SERIES PASS	7B	7A	EMITTER LEAD OF NPN SERIES PASS
			TM 5000 BARRIER SLOT
PWR	6B	6A	BASE LEAD OF NPN SERIES PASS
	5B	5A	
GROUND	4B	4A	GROUND
GROUND	3B	3A	GROUND
+8 FILTERED VDC	2B	2A	+8 FILTERED VDC
	1B	1A	

Note: These rear connector functions are active only when the coaxial cables are removed from the front panel connectors and reconnected to J3050 and J3051 on the A6 Timebase Board.

Figure 7-3: DDS/VCO Board Rear Interface

Static Sensitive Components

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free workstation by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the workstation surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction-type or wick-type desoldering tools.

Internal Fuse Replacement

WARNING

To avoid shock hazard, do not attempt to replace internal fuses with power applied to the SG 5050. Disconnect plug-in extender cables, if used, from the power module.

1. Remove the SG 5050 from the power module.
2. Remove the cabinet side panels, top rails and rear panel as described under Circuit Board Removal in this section.

WARNING

To avoid fire hazard, use only pico fuses of correct current rating as specified in Table 7-1 at the end of this section.

3. The SG 5050 has eight internal fuses soldered on various circuit boards. After fuse replacement, reinstall the cabinet panels in reverse order of removal. The fuses are shown on the individual board component layouts at the end of this section.

Cleaning

This instrument should be cleaned as often as operating conditions require. Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or a small brush. Remove dirt that remains with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

Cleaning the interior of a unit should precede calibration since the cleaning processes could alter the settings of calibration adjustments. Use low velocity compressed air (approximately 5 lb/in^2) to blow off accumulated dust. Hardened dirt can be removed with a soft brush or cloth dampened in a solution of water and mild detergent.

CAUTION

To prevent damaging circuit boards and components, allow time for drying before applying power.

Avoid using chemical cleaning agents that might damage plastic parts. Avoid chemicals containing benzene, toluene, xylene, acetone, or similar solvents.

Removal Instructions

While performing the following procedures, refer to the exploded-view assembly drawings at the end of this section. (33D30700).

WARNING

To avoid shock or fire hazard, remove any extending cables from the power module before continuing.

Cabinet Side, Top and Rear Panel Removal

The side covers, top rails and rear panel need to be removed for most repairs.

Side Cover Removal

The two side covers are snapped into the top and bottom rails of the SG 5050. To aid removal, there are cutouts at the rear corners of the covers. To remove, insert tweezers or a small straight-edged screwdriver into the cutout at the back edge of the cover, and carefully pry the cover away from the rail.

To replace covers, insert the front edge of the cover into the groove along the inside edge of the front frame assembly. Then press the cover down over the rails.

Release Latch Handle and Slider Removal

All plastic parts of the latch assemblies and the coil springs are individually replaceable. However, if latch tension spring becomes damaged, the attached bottom frame rail assembly must be replaced.

1. Remove the side covers from the SG 5050.
2. Pull the release latch handle out about 1/8 in. and hold.
3. Using a small screwdriver, move the release latch slider forward slightly while pushing down on the release latch handle with your finger to free the handle shaft from the slider. Pull out on the handle to remove.
4. To repair the release latch assembly, remove the bottom rail to which it is fastened. The rails are held with screws into the front and rear panel assemblies.
5. To replace the release latch handle, push the handle shaft through the slot in the front panel as far as it will go and hold it. Using a small screwdriver, move the release latch slider forward and the handle upward until the T-shaped end of the handle engages the end of the slider.

Rear Panel Removal

1. Remove side covers.
2. Remove the four screws holding the rear panel to the top frame assembly.
3. Remove the four guide studs holding the rear panel to the bottom chassis assembly. (Use a 3/16 in. hex wrench.)
4. Remove the rear panel.
5. Reassemble in reverse order.

Circuit Board Removal

Plug-in Circuit Board Removal

The following boards are plugged into the Interconnect Board (left to right, viewed from the rear):

Output Board
DDS/VCO Boards
CPU Board

To remove the plug-in boards:

1. Remove side covers.
2. Remove top rails and rear panel (as one unit) as follows:
   - Remove the six screws that secure the top rails to the front casting.
   - Remove the three screws from the center rail.
   - Remove the four guide studs holding the rear panel to the bottom chassis assembly.
3. Unplug all cable connectors on the board, keeping track of cable orientation and socket location.
4. Carefully unplug and remove the desired board from the Connector Board.

NOTE

Troubleshooting of the circuit boards in the SG 5050 is handled most easily with the use of flexible power module extender cables (67064502). Three power module extender cables are required.

CAUTION

The SG 5050 should not be operated for an extended period of time outside the power module unless an external fan can supply sufficient air flow over the Output circuit board to keep the circuit board components from overheating.

WARNING

Heatsinks and power resistors on several of the SG 5050 circuit boards can become hot enough to cause skin burns.

Front Panel Board Removal

1. Remove side covers.
2. Remove release latch handles.
3. Remove 12 screws holding front panel assembly to top and bottom frame assemblies.
4. Unplug the ribbon cable from the front of the CPU Board. Unplug the two Output Head connector cables from the circuit boards. Pull the front panel assembly away from the top and bottom frame assemblies and unplug the two timebase cables from the front panel connectors. Note the locations of the coaxial cables at the front panel connectors for reconnection.
5. Remove four screws from the front panel board and lift the circuit board away from the front panel casting.
6. Reassemble in reverse order of removal.

Connector Board Removal

1. Remove all circuit boards that plug into the Connector Board.
2. Remove the hardware that secures the power transistor to the bottom frame assembly.
3. Remove the six screws that secure the Connector Board and lift away from the bottom frame assembly.
4. Reassemble in reverse order of removal.

Mechanical Assemblies, Component Layouts, and Replacement Parts

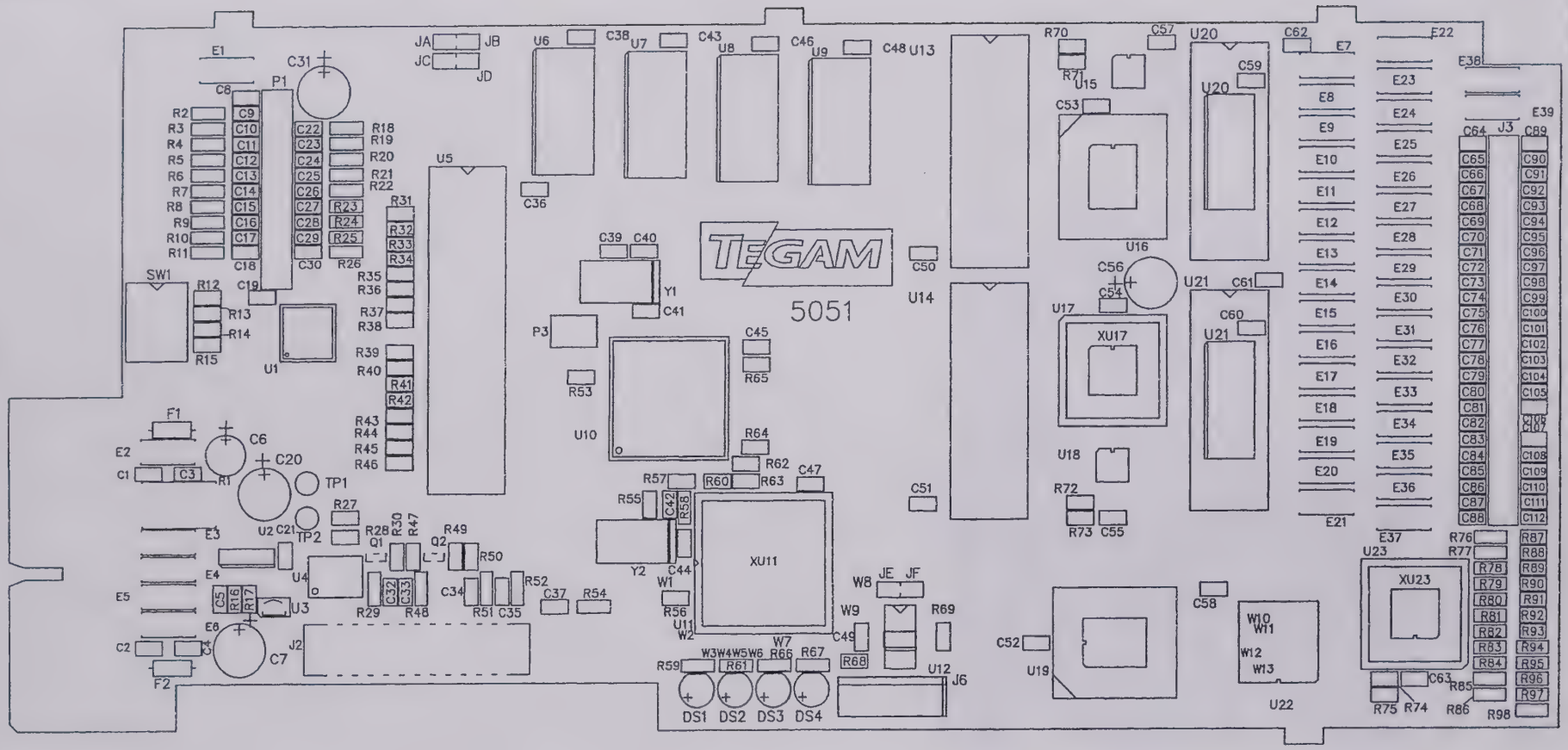
Foldouts of these mechanical assembly drawings and PCB component layout drawings are at the end of this section:

33D30700	Exploded Assembly Diagram (2 Sheets)
90D26900	CPU DIAGRAM
90D27100	DDS DIAGRAM
90D27202	VCO DIAGRAM (2 Sheets)
90D28502	DECK DIAGRAM
90D28602	AMP DIAGRAM
31C34800	A3 ASSEMBLY
31C24700	A4 ASSEMBLY
31D28600	A5 ASSEMBLY

Replacement parts are ordered from TEGAM. The instrument model number, specific part number and description found in Table 7-1 or the assembly drawings in this section are required.

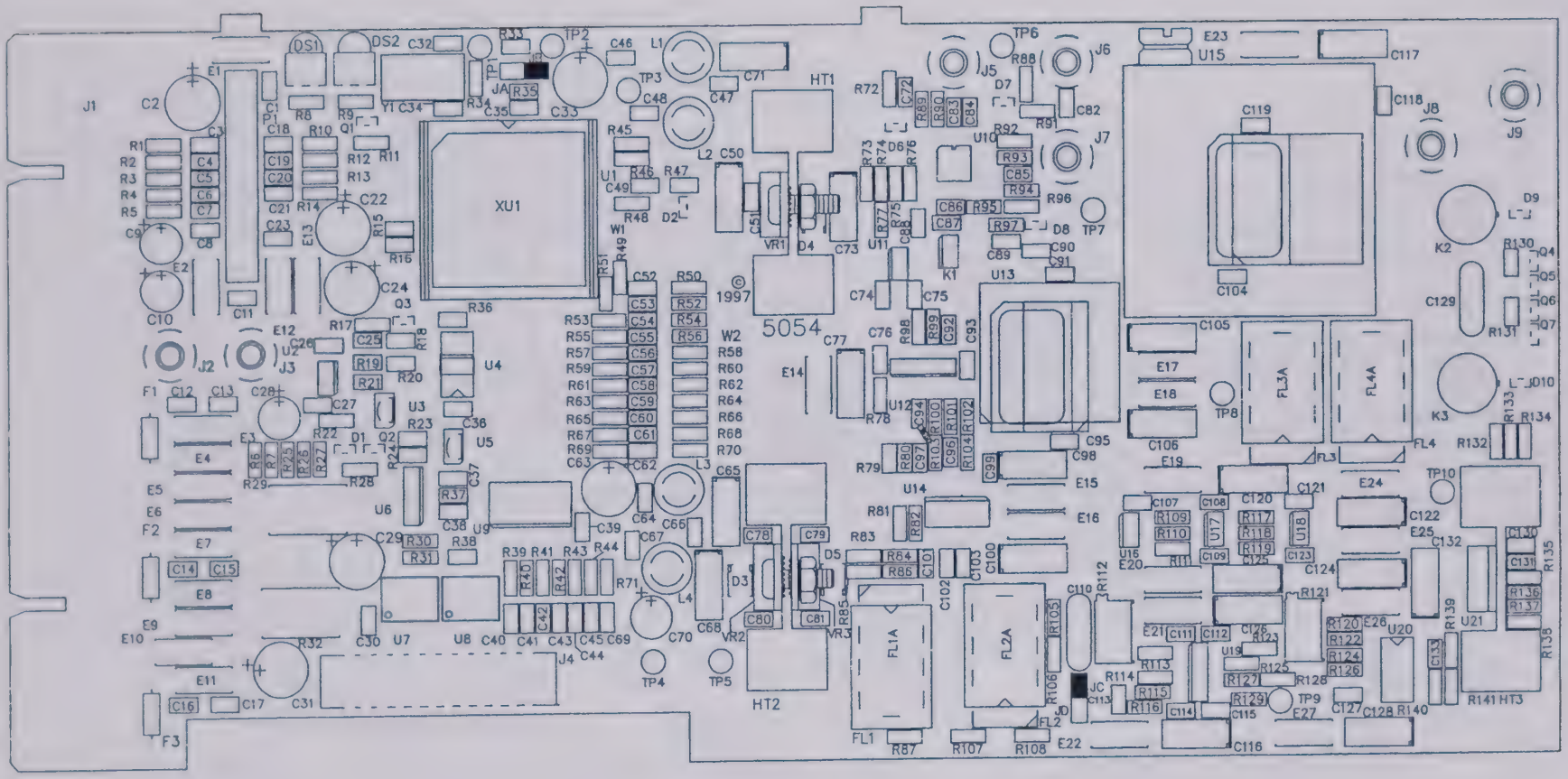
Table 7-1: Replacement Parts

Description	Part Number
Connection Board Assembly (A2)	30C24001
Connection Board	48C21001
CPU/GPIB Board Assembly (A3)	31C34800
CPU Board (A3A1)	30D23300
GPIB Board (A3A2)	30D23200
DDS/VCO Board Assembly (A4)	31C24700
DDS Board (A4A1)	30D23903
VCO Board (A4A2)	30D23703
Front Panel Assembly	23B07800
Leveling Head Assembly (A6)	SG5050-LH
Manual	70505000
Output Deck/Output Amp Assy. (A5)	31D28600
Output Deck Board (A5A1)	30D24802
Output Amp Board (A5A2)	30D25002
Extenders	
Power Module Extender Cable	67064502



TOP SILK SCREEN
90D26900

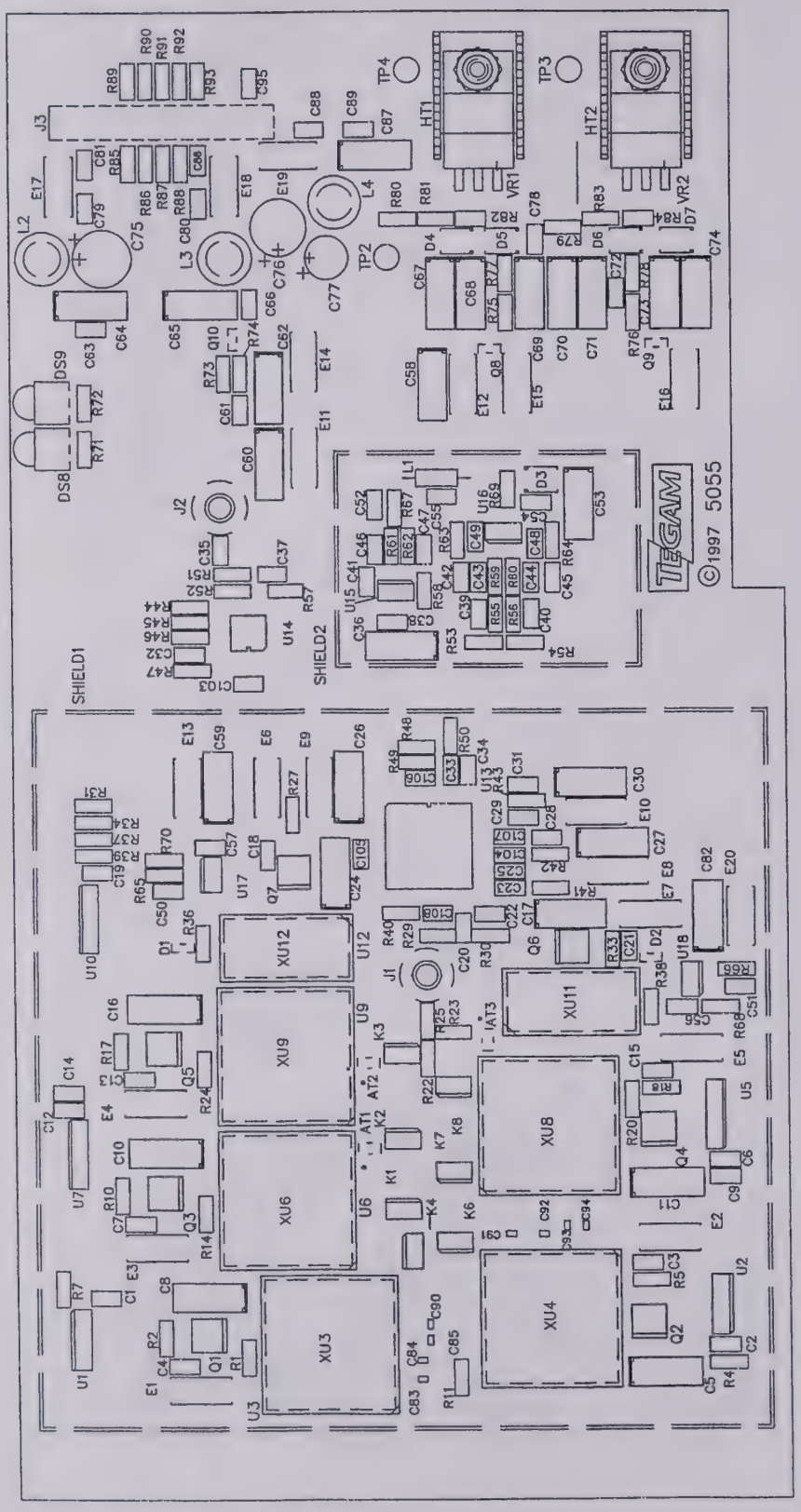
Replacement Fuse F1 Pico Fuse .25 Amp
F2 Pico Fuse 3 Amp



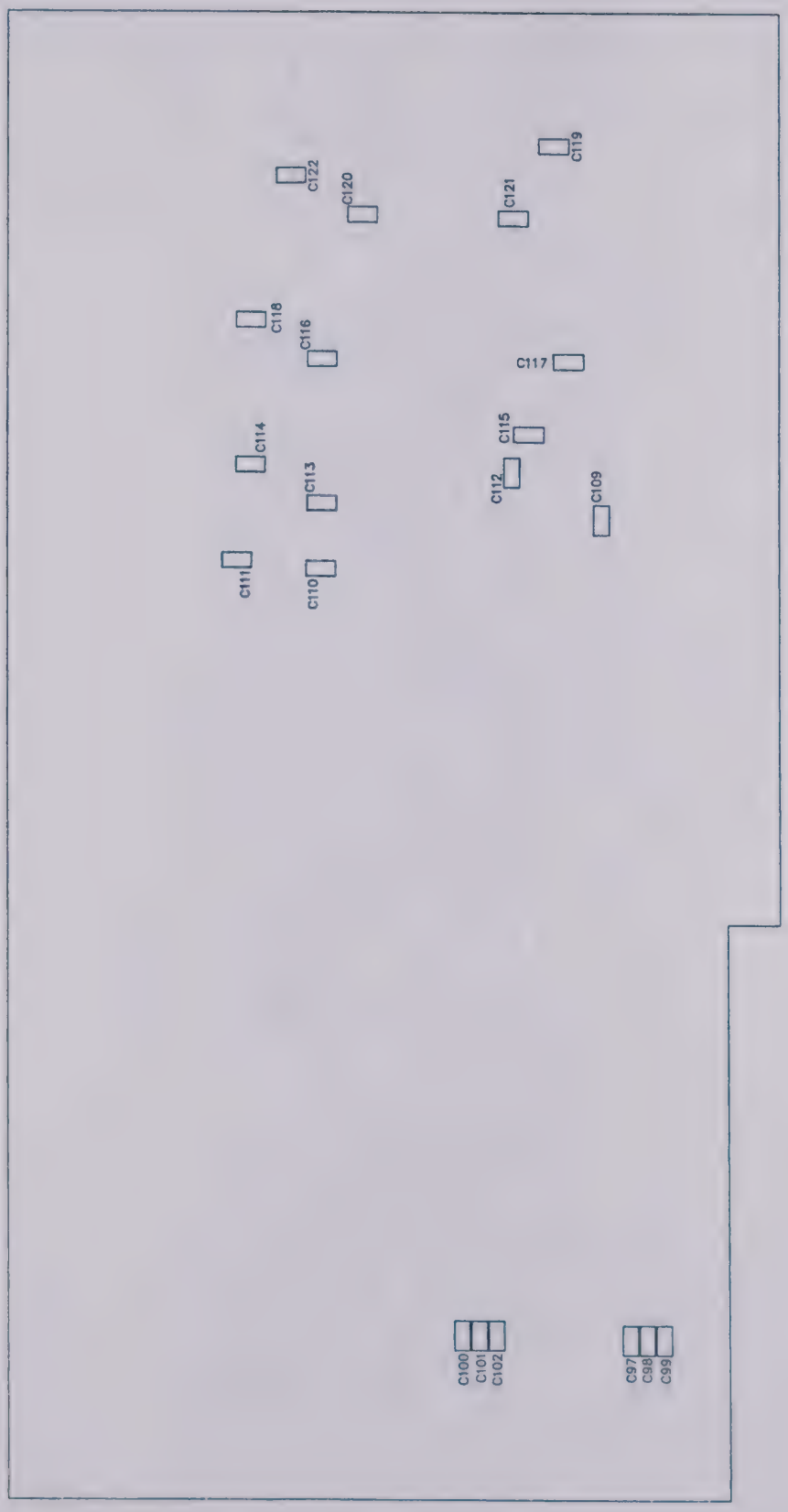
SILK SCREEN

90D27100

Replacement Fuse F1 Pico Fuse 1 Amp
F2 Pico Fuse 1 Amp
F3 Pico Fuse 3 Amp



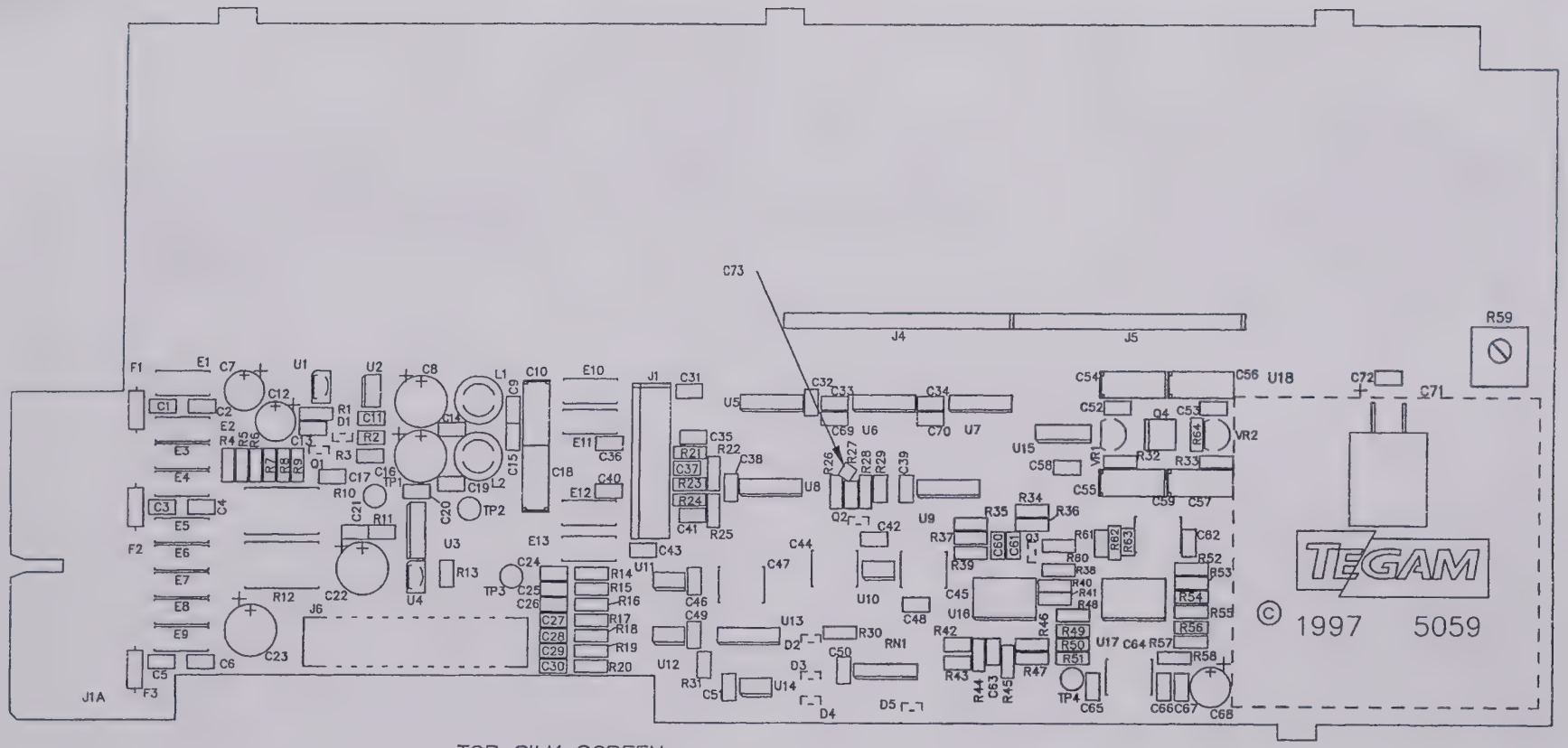
TOP SILK SCREEN
90D27202
SHEET 1 OF 1



BOTTOM SILK SCREEN

90D27202

SHEET 2 OF 2



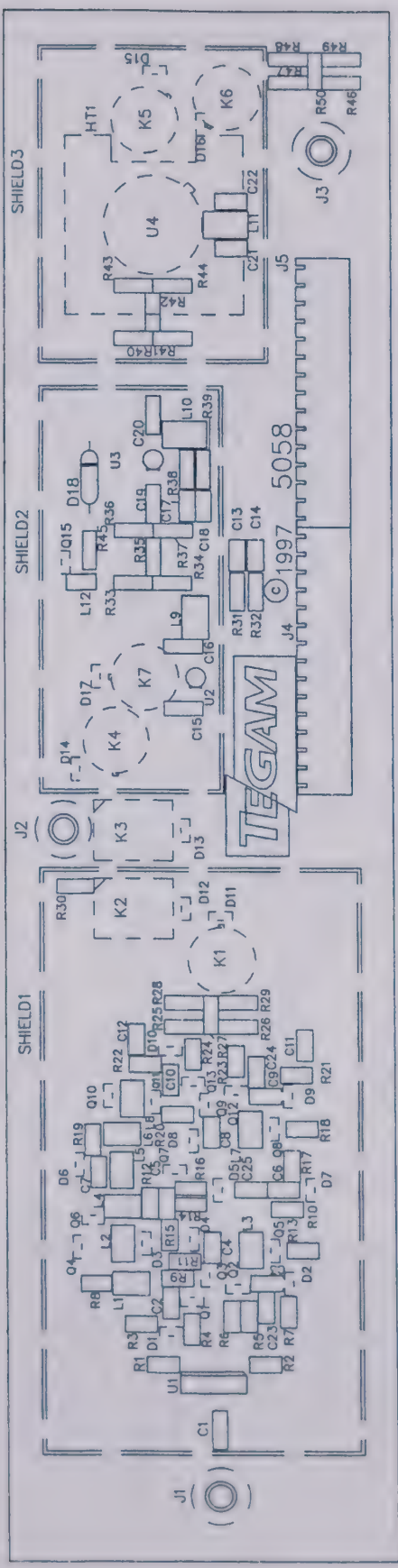
TOP SILK SCREEN

90D28502

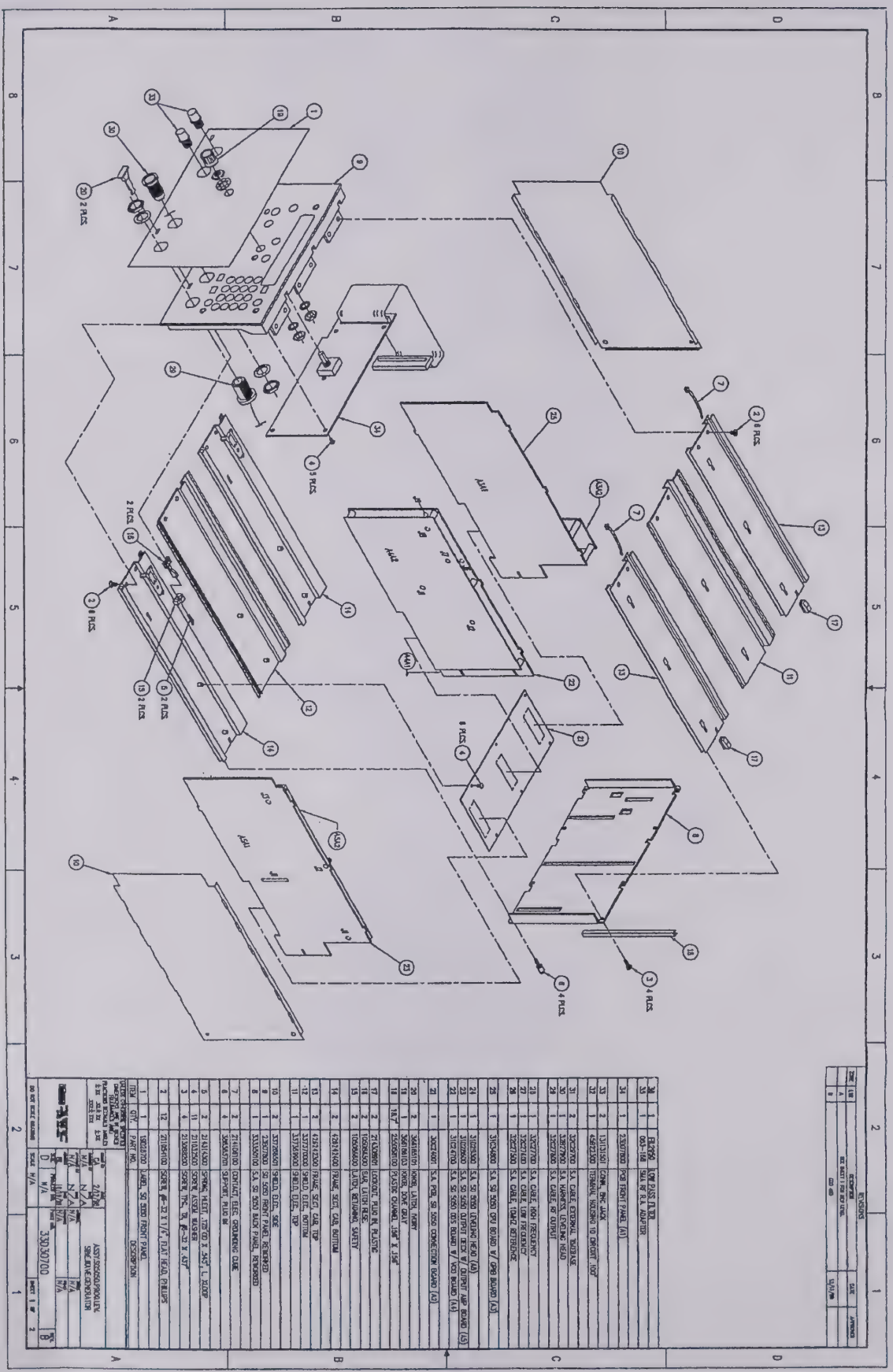
Replacement Fuse F1 Pico Fuse 1 Amp

F2 Pico Fuse 1 Amp

F3 Pico Fuse 3 Amp



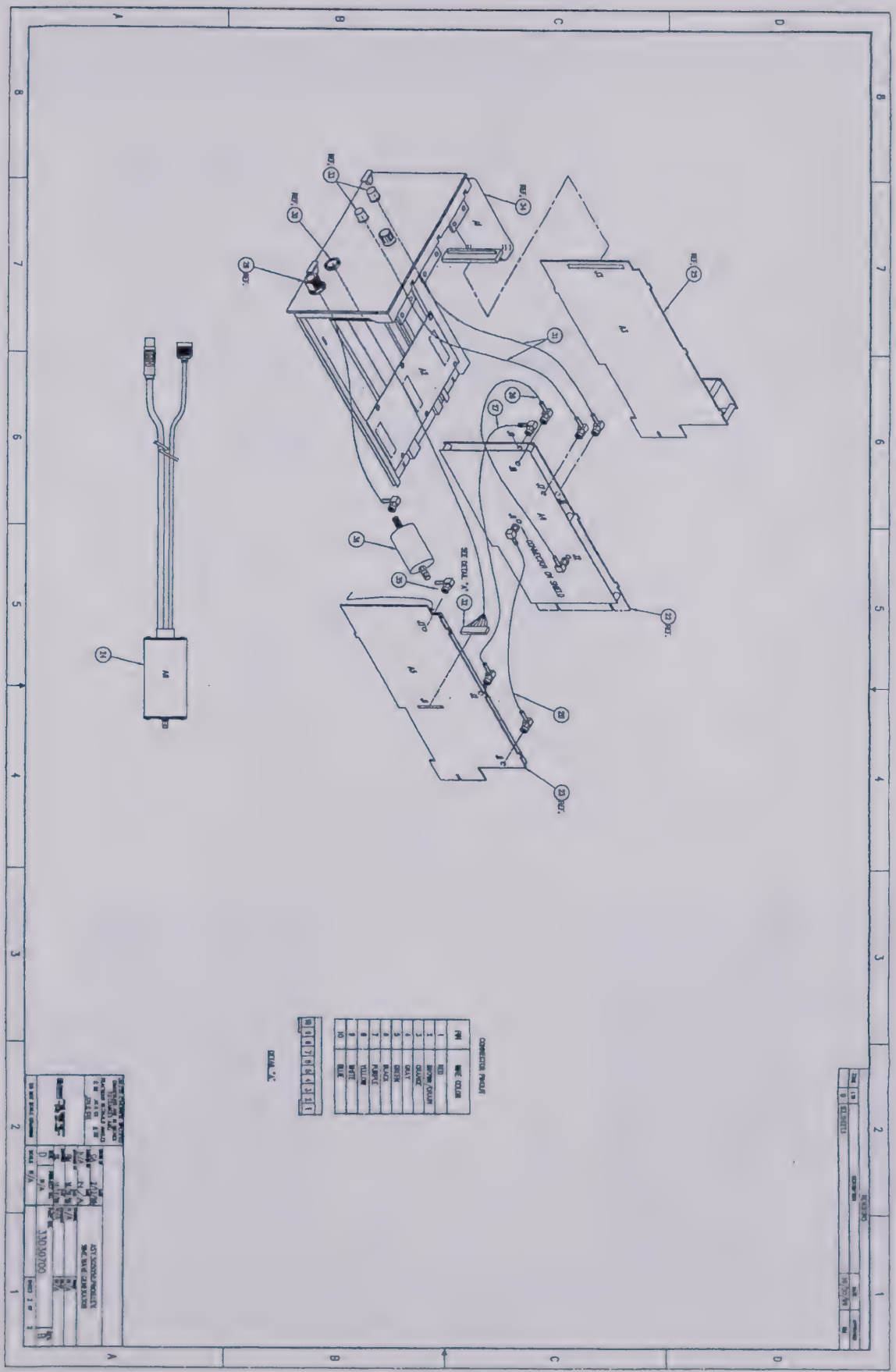
TOP SILK SCREEN
90D28602

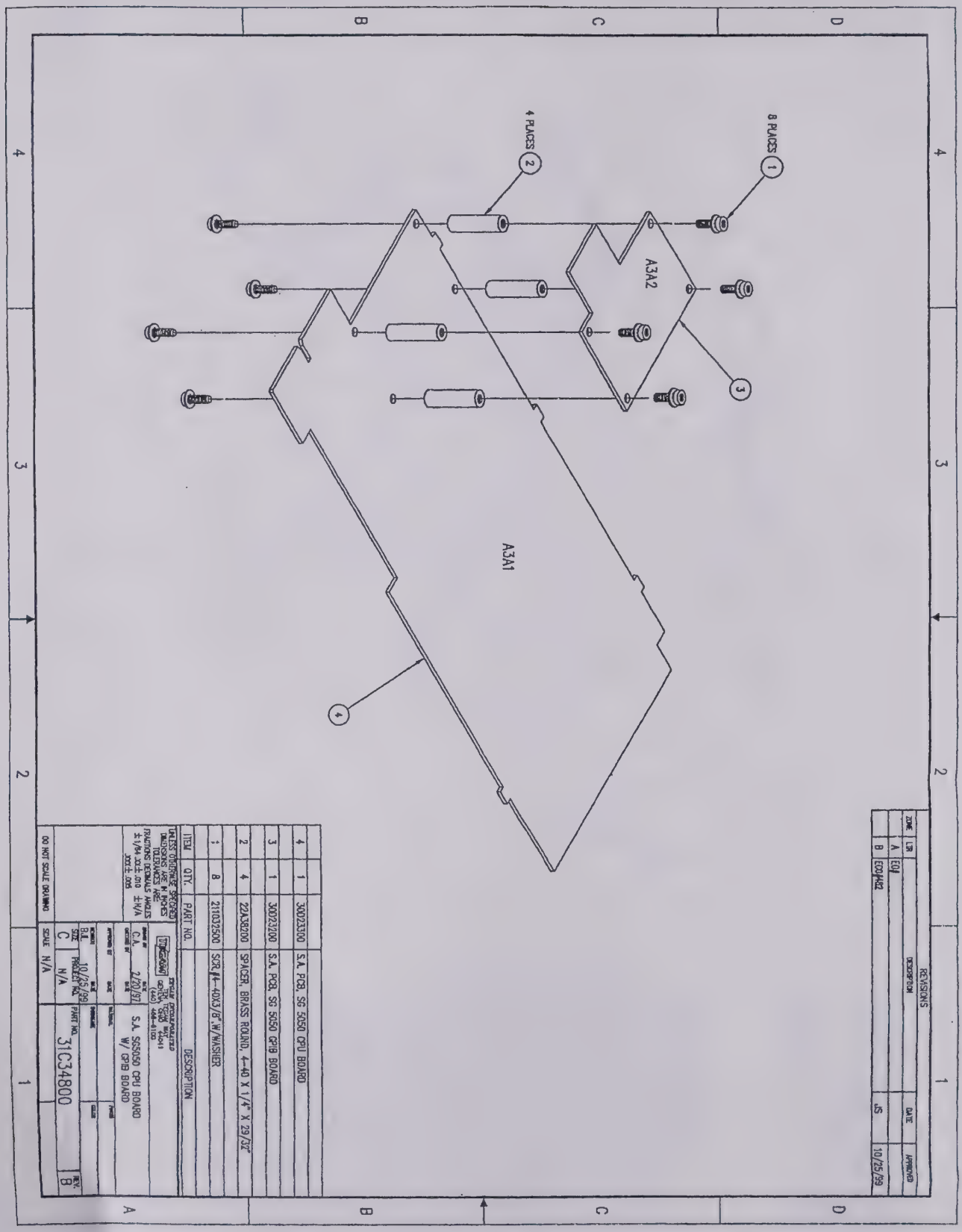


ITEM	QTY.	PART NO.	DESCRIPTION
1	1	1980370D	LABEL, SG 5050 FRONT PANEL
2	12	2115410D	SCREW, #6-32 X 1/4", FLAT HEAD, PHILIPS
3	4	2130860D	SCREW, TPG, "B", #6-32 X .437"
4	11	2110325D	SCREW, LOCK WASHER
5	2	2143150D	SPRING, LATCH, .120 ID X .345" L, BLOOP
6	4	3830407D	SUPPORT, PLUG IN
7	2	2116010D	CONTACT, ELEC, CRIMPING CONE
8	1	3333307D	S.A. SG 5050 BACK PANEL, REWORKED
9	2	2367780D	SG 5050 FRONT PANEL RESERVED
10	2	3372860D	SHIELD, ELEC, SIDE
11	1	3375490D	SHIELD, ELEC, TOP
12	1	3375470D	SHIELD, ELEC, BOTTOM
13	2	4391140D	FRAME, SECT, CAB, TOP
14	2	4391150D	FRAME, SECT, CAB, BOTTOM
15	2	1100860D	LATCH, RETAINING, SAFETY
16	2	2143980D	LOCKOUT, PLUG IN, PLASTIC
17	2	1100840D	BAR, LATCH RELE-
18	167"	2555001D	PLASTIC CHANNEL, .188" X .156"
19	1	3661861D	PANEL, REAR, MARY
20	2	3661861D	PANEL, REAR, DARK GRAY
21	1	3027430T	S.A. PCB, SG 5050 CONNECTION BOARD (A5)
22	1	3102470D	S.A. SG 5050 OUTPUT DECK W/ OUTPUT AMP BOARD (A9)
23	1	3102780D	S.A. SG 5050 OUTPUT DECK W/ CKT BOARD (A4)
24	1	3105400D	S.A. SG 5050 CPU BOARD W/ GPIB BOARD (A3)
25	1	3102530D	S.A. SG 5050 LEVELING HEAD (A8)
26	1	3227130D	S.A. CABLE, LOW FREQUENCY
27	1	3227710D	S.A. CABLE, LOW FREQUENCY
28	1	3226730D	S.A. CABLE, TUNNEL RETENTION
29	1	3387790D	S.A. MARKERS, LEVELING HEAD
30	1	3387790D	S.A. CABLE, RF OUTPUT
31	2	3900870D	S.A. CABLE, EXTERNAL TRIGGER
32	1	4582230D	TERMINAL HOUSING TO CIRCUIT .100"
33	2	1313150I	CONN, PNC JACK
34	1	2380780D	POST FRONT PANEL (A6)
35	1	0063-198	SMA M F.K. ADAPTOR
36	1	8429901	LOW LOSS FLEX

REVISIONS			
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 5050	12/15/88	
	B	ADDED 1100 HZ OPTION ECO 5050		

DO NOT SCALE DRAWING		ASSY 5050 OPTION 001 SINGLE CHANNEL GENERATOR	
SCALE N/A	WEIGHT N/A	SIZE D	DWG NO 3300700	REV B
		SHEET 1 OF 2	




8 PLACES
4 PLACES
A3A2
A3A1
REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
A
B
ECO
10/25/99
JS
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3
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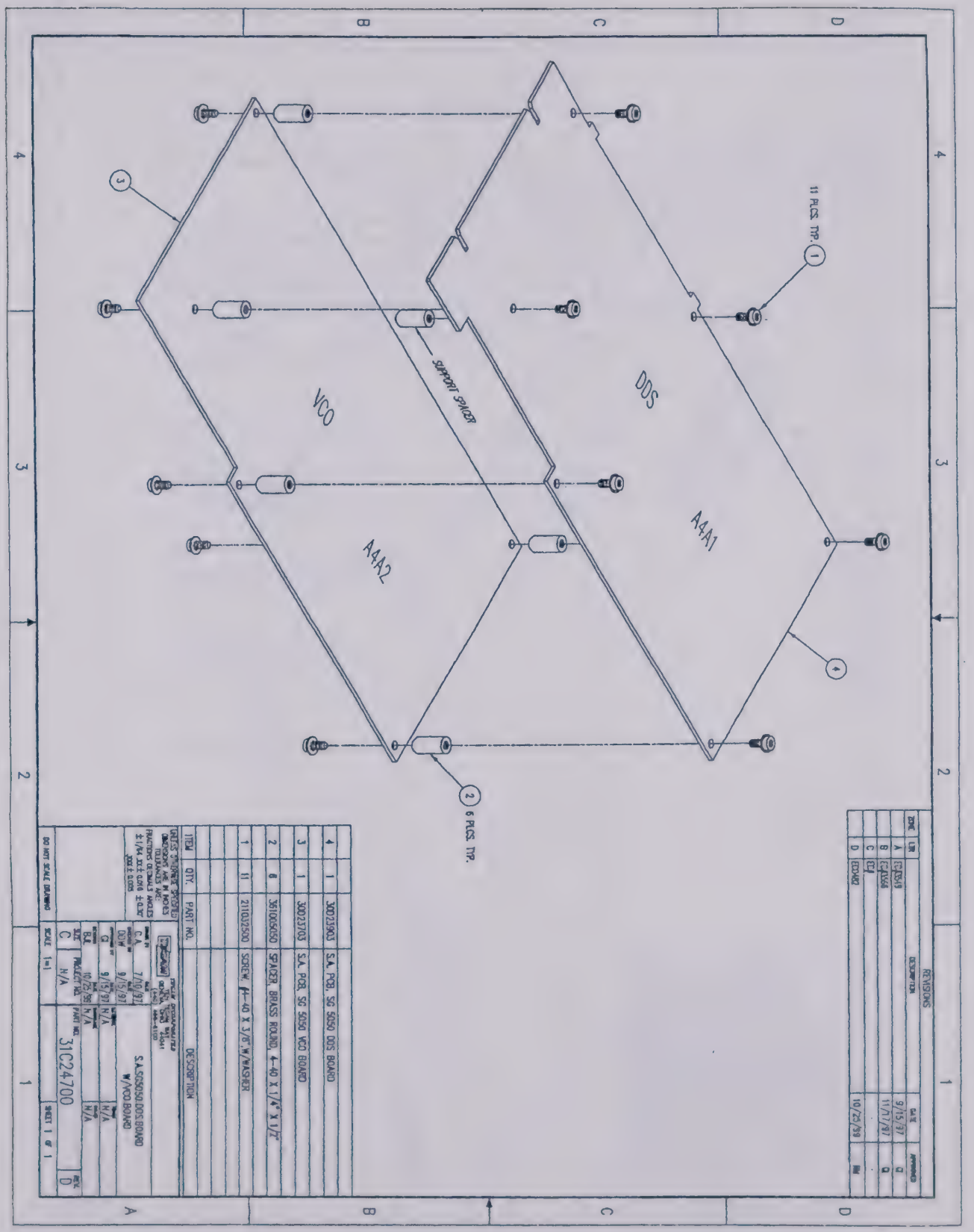
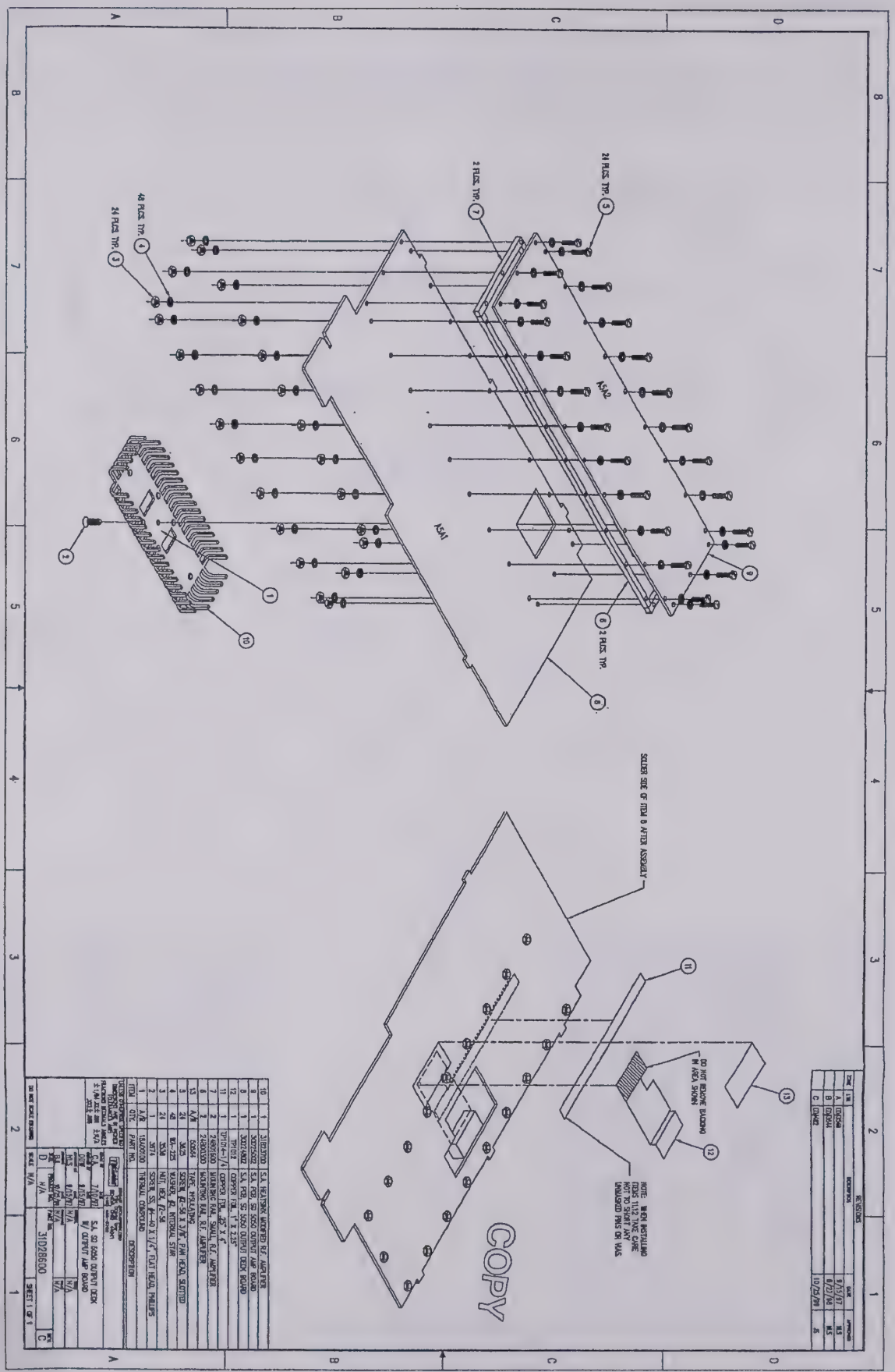
1
A
B
C
D
DO NOT SCALE DRAWING
SCALE N/A
SIZE C
PROJECT NO. N/A
PART NO. 31C34800
REV. B
B.L.
10/25/99
ITEM
QTY.
PART NO.
DESCRIPTION
4
1
30D23300
S.A. PCB, SG 5050 CPU BOARD
3
1
30D23200
S.A. PCB, SG 5050 CPIB BOARD
2
4
22A38200
SPACER, BRASS ROUND, 4-40 X 1/4" X 29/32"
1
8
21103500
SCR #4-40X3/8" W/WASHER
S.A. SG5050 CPU BOARD W/ CPIB BOARD
C.A.
2/20/97


11 PLCS. TYP.
1
SUPPORT SPACER
VCO
DDS
A4A2
A4A1
3
4
2
6 PLCS. TYP.
REVISIONS
DESCRIPTION
APPROVED
9/15/97
11/17/97
10/22/98
ITEM
QTY.
PART NO.
DESCRIPTION
1
1
30031903
S.A. PCB, SG 5050 DDS BOARD
3
1
30023703
S.A. PCB, SG 5050 VCO BOARD
2
6
36100S050
SPACER, BRASS ROUND, 4-40 X 1/4" X 1/2"
1
11
21103J2500
SCREW, #4-40 X 3/8" W/WASHER
S.A.SG5050 DDS BOARD W/VCO BOARD
31024700
SHEET 1 OF 1


21 PLCS. TYP.
2 PLCS. TYP.
21 PLCS. TYP.
48 PLCS. TYP.
24 PLCS. TYP.
2 PLCS. TYP.
SOLDER SIDE OF ITEM 8 AFTER ASSEMBLY
DO NOT REMOVE BUSHING IN AREA SHOWN
NOTE: WHEN INSTALLING ITEMS 11&12 TAKE CARE NOT TO SHORT ANY UNUSED PINS OR VIAS
COPY

ITEM	QTY.	PART NO.	DESCRIPTION
10	1	31028700	S.A. HEATSINK MODIFIED REF. AMPLIFIER
9	1	30012402	S.A. PCB, SG 5050 OUTPUT AMP BOARD
8	1	30014402	S.A. PCB, SG 5050 OUTPUT DECK BOARD
12	1	TP1012	COPPER TAB, 1" X 2.25"
11	1	TP1018-1/4	COPPER TAB, .25" X 4"
7	2	2480160	WASHER, FLAT, SMALL, REF. AMPLIFIER
13	A/R	15664	WASHER, FLAT, REF. AMPLIFIER
5	24	MS25	SCREW, #6-32 X 1/4" PAN HEAD, SLOTTED
4	48	MS-225	WASHER, #6 INTERNAL STAR
3	24	3539	NUT, HEX, #6-32
2	1	3574	SCREW, SS, #4-40 X 1/4" FLAT HEAD, PHILLIPS
1	A/R	15400700	THERMAL COMPOUND

DRAWN	DATE	9/15/97	S.A. SG 5050 OUTPUT DECK W/ OUTPUT AMP BOARD
CHECKED	DATE	9/22/98	
ENGR APPROVAL	DATE	10/23/98	
MFG APPROVAL	DATE	N/A	
Q.A. APPROVAL	DATE	N/A	
COMMENTS:			
NEXT ASSY USED ON			
APPLICATION			
DO NOT SCALE DRAWING			
SIZE D	FSCM NO. N/A	31028600	REV C
SCALE N/A		SHEET 1 OF 1	

ZONE	ITR	DESCRIPTION	DATE	APPROVED
	A	DCR540	9/15/97	BKS
	B	DCR544	9/22/98	BKS
	C	DCR642	10/23/98	BS

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Warranty

TEGAM, Inc. warrants this product to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, we will at our option, either repair or replace any product that proves to be defective.

TEGAM, Inc. warrants the calibration of this product for a period of one year from date of shipment. During this period we will recalibrate any product that does not conform to the published accuracy specification.

To exercise the warranty, contact TEGAM, Inc., Ten TEGAM Way, Geneva, Ohio 44041, phone 440-466-6100, fax 440-466-6110, M-F, 8 a.m.-5 p.m. ET. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned, transportation prepaid. Repaired products are warranted for the balance of the original warranty, or at least 90 days, whichever is longer.

Limitation of Warranty

TEGAM, Inc. warranty does not apply to defects resulting from unauthorized modification or misuse of any product or part. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular use. TEGAM, Inc shall not be liable for any indirect, special or consequential damages.

Statement of Calibration

This instrument has been inspected and tested in accordance with specifications published by TEGAM, Inc.

The accuracy and calibration of this instrument are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards maintained in the Laboratories of TEGAM, Inc.

How to Contact TEGAM

TEGAM, Inc.
Ten TEGAM Way
Geneva, OH 44041

Phone: 440-466-6100
Fax: 440-466-6110
e-mail: sales@tegam.com
web: www.tegam.com

Warranty of Traceability

The reference standards of measurement of TEGAM, Inc. are compared with the U.S. National Standards through frequent tests by the U.S. National Institute of Standards and Technology. The TEGAM working standards and testing apparatus used are calibrated against the reference standards in a rigorously maintained program of measurement control.

The manufacture and final calibration of all TEGAM instruments are controlled by use of the TEGAM reference and working standards and testing apparatus in accordance with established procedures and documented results. (Referenced MIL-STD-45662A.)

Final calibration of this instrument was performed with reference to the mean values of the TEGAM reference standards or to the ratio devices that were verified at the time and place of use.

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